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ABSTRACT

The objective of this monograph is to contribute to the further understanding of the knowledge-production-and-utilization process. Its primary focus is on a model both general and detailed enough to provide a comprehensive overview of the diverse functions, roles, and processes required to understand the flow of knowledge from its point of origin to points of utilization. The model is organized into a six-stage paradigm of knowledge-production-and-utilization. Within each of these stages, concepts are defined, discussed, illustrated, and, to some degree, interrelated. Recognized problems areas such as missing concepts, missing interrelations, or redundancy are pointed out. The presentation is divided into three sections. First, the six general stages are identified and explained. Second, the steps performed within each stage are presented in a "static" model of knowledge-production-and-utilization. Finally, the same stages and steps are represented in an "iterative dynamic" model that illustrates ways in which the process might occur under actual conditions. The synthesis is intended to enable researchers and practitioners to identify more precisely strengths and weaknesses of those areas of the knowledge-production-and-utilization chain of most interest to them. (Author/JM)

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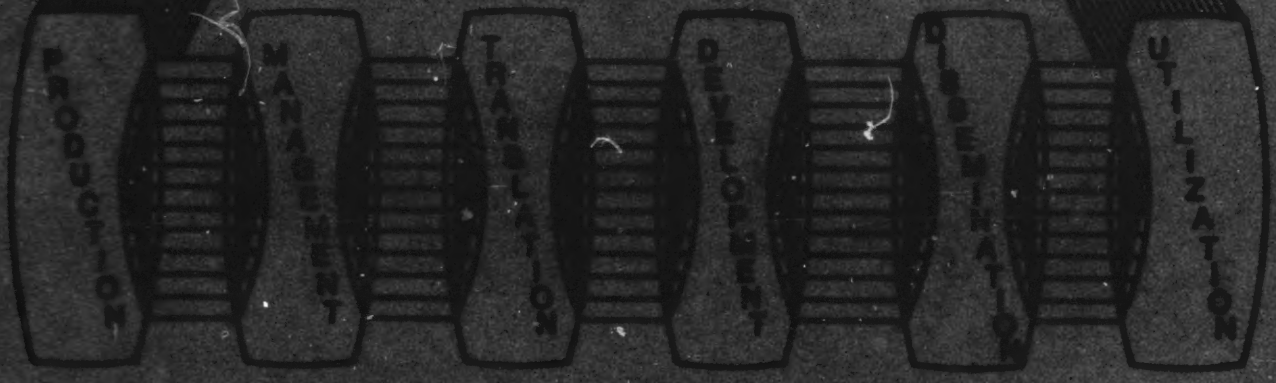
KNOWLEDGE PRODUCTION & UTILIZATION: A GENERAL MODEL

-THIRD APPROXIMATION-



by

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Sociology Report No. 138
Department of Sociology and Anthropology

July, 1977
Iowa State University
Ames, Iowa

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A GENERAL MODEL

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PREFACE

To many people, including the authors of this monograph, the attempt to understand the knowledge-production-and-utilization process goes beyond academic curiosity. There appear to be growing concerns regarding the inefficiency and, in some cases, lack of knowledge-utilization structures and processes in our society. These concerns take many forms. There are those who believe that public and private investment in research is not returning to the society the benefits that it could and should be returning. There is concern about the relevance of much research to society's operation and problems. There is concern about the apparent indifference of many scientists to whether their research findings are used in solving society's problems. There is concern that there are few, if any, organizations that can bring together ultimate user or client needs and problems with the available knowledge to help meet those needs or solve the problems. There is concern that the knowledge-production-and-utilization process tends to serve the elite, the well-off; while those less fortunate, who are thought to need the knowledge most, become relatively worse off.

Regardless of these, and other stated concerns, there is an emerging belief in the need to attempt to better conceptualize and understand the knowledge-production-and-utilization process. There is the belief that this basic conceptualization and understanding will make a major contribution to more effective knowledge-production-and-utilization. This feeling is shared by many of those highly involved in knowledge dissemination and utilization--the practitioners and those in "applied" fields. A small group of scientists have made contributions to a better understanding of the process. Each of them emphasizes the importance of additional work in this area.

Despite differences in age, disciplines and experience the authors of this monograph share several things in common. Both are strongly committed to knowledge-production-and-utilization to help solve ultimate user, client needs. The second author has a long history of social science research. Equally relevant is his long term commitment to knowledge dissemination and utilization. He has worked as an applied researcher, consultant, trainer, and educator with literally hundreds of private companies, trade associations, government agencies, voluntary associations, adult education groups and media-related groups. These experiences have varied from local to international. The first author approaches the subject from a background in communications and anthropology and a strong interest in knowledge-production-and-utilization from a cross-cultural perspective. He has worked in print media as an editor, writer, and public relations coordinator. As a YMCA program director in Asia over a several year period, he worked with various client-systems as a trainer, consultant and program-organizer. These experiences introduced him to a number of actual problems of knowledge-utilization.

This Agricultural and Home Economics Experiment Station project grew out of a belief, held in common by the two authors, that their (and hopefully other practitioners) long run objective of more effective knowledge-production-and-utilization could best be served by a short-run attempt to review the literature, taxonomies and models in the field and, using this knowledge as a partial base, attempt to develop a model that would, for them, best provide a guiding framework for effective knowledge-production-and-utilization. The first author took major responsibility for the beginning review of literature and the first specification of the model.

As is often the case in academia, as the project was just well underway both authors were faced with changes in roles: one taking a short, international assignment and changing his role to teaching, and the other taking a year leave of absence. Two major alternatives were available: 1) a discontinuance of project activity with the usual hope and promise that we would try to continue our activity by correspondence and possible meetings and bring some degree of closure on the project, or 2) fully recognizing we were not at a point in the project to attempt to bring highly productive closure, go ahead anyway and do our best to put in writing our present personalized state of the art. This monograph indicates we chose the second alternative. We fully recognize our thinking is still in the formative stage. We realize there are many gaps; many unanswered questions. Much elaboration and clarification is needed. We have had little opportunity to "field test" the model. As stated in the title, it is an approximation--our third, but first published approximation. We believe choosing this alternative has forced us to pull together what we think we know recognizing in the process the vast amount of what we don't know. It will provide a basis for our personalized evaluation of next logical steps. Hopefully it can provide a similar basis for evaluation and next-step actions for others interested in this area.

We have had to work under tight time constraints to produce this approximation before our changes in roles. We wish to gratfully acknowledge the help of several people who have made contributions to our completing the task: to secretaries and typists Debbie Dannen, Liz Flattebo, and Marjorie Whitney; to Rich Beachler for preparation of

illustrations. We also wish to thank Dr. Louis St. Peter, Department of Sociology, for his help in setting up the computerized annotated bibliography phase of the project and to Gregory Epping for his assistance in preparing the bibliography.

And finally we express our appreciation to Dr. Ronald Powers, Assistant Director of the Agriculture and Home Economics Experiment Station and Assistant Director of the Cooperative Extension Service for his encouragement of the project. As can be seen from his position his administrative role clearly spans the knowledge-production-and-utilization process from basic and applied research in the Experiment Station to dissemination through the Extension Service. The criteria of successful dissemination is client use. Thus, Dr. Powers has more than just a passing interest in this project. We hope he, as well as other readers, will find this "third approximation" of a general model of knowledge-production-and-utilization of value.

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July 1977

P.M.M.
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I.

INTRODUCTION

A search for the origins of the concept of knowledge-production-and-utilization might well begin with the man who gave the Western world a new method of scientific inquiry--the seventeenth century philosopher and father of modern science, Sir Francis Bacon. Bacon pioneered a research procedure which evolved into the immensely productive experimental method. However, his concern went beyond knowledge-production to the systematic application of knowledge to solve people's problems.

> The purpose of [Bacon's Novum Organum]is to discover the nature of things and to produce arts and works.... To produce works, man must know causes; and these he can discover only through what he observes of nature's structures and ways. What in knowledge is the cause is in operation the rule (Anderson, 1948:183).

These "rules" are embodied in technologies (or "works") and then used by people in society. In this way, knowledge follows a course from production through development to dissemination and finally utilization to help solve people's problems. According to Bacon, the ideal knowledge-utilizing society "will command nature in operation and provide the human race with new inventions" (Anderson, 1948:183). He sketched this society in his Utopian New Atlantis. Thus, Sir Francis Bacon, at the dawn of the modern scientific era, glimpsed the rudiments of a process central to the formation of our modern industrial society. Some analysts may say the process of knowledge-production-and-utilization is understood little better today than it was by Bacon three centuries ago.

Despite this early awareness of the knowledge-production-and-utilization process, its systematic study was virtually ignored by scholars until some 20 years ago. Impressed by the paucity of knowledge of such an important phenomenon, a small group of scholars, primarily in education and the social science, directed their endeavors toward understanding the process to the end that there would be more efficient and greater use of knowledge.

In 1960, Havelock and associates introduced what is judged to be the first comprehensive study of the subject with the words:

> There is a new field of knowledge emerging in the 1960's which might be described as the "science of knowledge utilization." It is probably misleading however, to describe this emerging discipline as a "science" at this point in time. In reality, knowledge-utilization is at most a crude art occupying the individual attention of only a small scattering of scholars in three or four centers of learning. There are no schools, no curriculars and few courses for training researchers and practitioners in this area, and there is as yet only a dim awareness on the part of the nation as a whole that this field deserves extensive public support (1969:1-1).

The consequences arising from this lack of understanding of the knowledge-production-and-utilization process are at least two-fold. First, it is possible that a large amount of research is wasted due to the absence of proper mechanisms to develop, adapt, and disseminate it for utilization. As Rogers and Jain say, "such unapplied scientific knowledge, remains an unrealized public investment" and, for this reason, "legislative committees have recently began to question federal government agencies as to how practice has changed as a result of past research expenditures by the agency" (1969:2). Second, solutions to societal problems may exist but lie dormant in the scientific community because mechanisms for utilizing it are lacking.

The objective of this monograph is to contribute to the further understanding of the knowledge-production-and-utilization process. Its primary focus is on a model sufficiently general, yet detailed enough, to provide a comprehensive overview of the diverse functions, roles, and processes required to understand the flow of knowledge from its point of origin to points of utilization. The model aims explicitly toward completeness, but recognizes that any claim for completeness would be premature with the present state of knowledge. The need for attempts at synthesis is suggested by Rothman: "Numerous scholars have studied various aspects of the knowledge utilization or application process, yet one senses this is still a largely intuitive, underdeveloped intellectual area" (1974:532). More specifically, Rogers and Jain write:

> We lack a very complete picture of the total process. We need studies in which the entire cycle of research utilization is described, by tracing a particular innovation or innovations from client needs, to research, through linkers, to clients (1969:7).

In attempting to meet our objective, we have reviewed relevant works from the fields of marketing, industrial research and development (R&D), systems engineering, educational R&D, agricultural extension, social work, technology assessment, and technology transfer. Based on this review, and our own interactions with a number of scholars, we believe a logical next step is to attempt to specify our present state of conceptualization, knowledge, and application. We believe this preliminary attempt at closure will force us to codify and integrate what we have learned, recognize inconsistencies and gaps in the present state of knowledge, provide opportunity for creative conceptualization, and indicate to us logical next steps to be undertaken. We hope that others concerned with the problem may profit from our personalized "state of the art" statement.

We have organized our presentation within a six-stage paradigm of knowledge-production-and-utilization. Within each of these stages concepts are defined, discussed, illustrated and to some degree interrelated. Recognized problem areas (e.g., missing concepts, interrelations, redundancy, and application) are pointed out.

Our presentation is divided into three sections. First, the six general stages are identified and explained. Second the steps performed within each stage are presented in a "static" model of knowledge-production-and-utilization. Finally, the same stages and steps are represented in an "iterative, dynamic" model which illustrates ways in which the process might occur under real-world conditions.

In summary, we are drawing preliminary closure to our study of knowledge-production-and-utilization with the idea that his synthesis will enable both researcher and practitioner to identify more precisely strengths and weaknesses of those areas of the knowledge-production-and-utilization chain of most interest to them. Thus, while the world described by Bacon in his New Atlantis is a useful ideal, our concern is with the real world of today and the utilization of knowledge to solve its problems.

II.

KNOWLEDGE-PRODUCTION-AND-UTILIZATION: DEFINITIONS, HISTORY, AND THEORETICAL APPROACHES

A. A Working Definition

Elements of a definition of knowledge-production-and-utilization may be common to several related terms, including research-utilization, technology-utilization, and knowledge-utilization. Research utilization has been defined as "the process by which research results are communicated to, and effectively used by, clients" (Rogers and Jain, 1969:3). Rothman, from the field of social work, has defined research utilization as "the systematic application of research findings to practical aspects of community action and planned social change in order to deal with contemporary social problems" (1974:1). From the field of education, Jung and Lippit state that research utilization occurs to the extent that scientific knowledge is used in the problem-solving phases of planned change (1966:26). Referring to industry, Havelock and Benne conceive of research-utilization as a "problem-solving" or "need-fulfillment system where a consumer expresses a need to a resource person who finds resources to satisfy a need and transmits the resources to the consumer so that he can utilize them" (Havelock and Benne, 1969:126). Hersman defines technology utilization as "the process by which existing knowledge is translated operationally into useful processes, products, or programs which fulfill actual public or private needs" (1973:84). Each of these definitions has its own points of emphasis, and we draw from these to develop our own working definition of knowledge-utilization.

First, as Havelock and Benne say, knowledge-production-and-utilization comprises a system--a "problem-solving system"--composed of subsystem parts, each of which interacts with and affects the other. Second, it is a rationalized system in which the form and interaction of subsystem parts are planned so as to achieve certain results. Thus, knowledge-production-and-utilization is, thirdly, a goal-directed, result-oriented system with two general aims: to meet client needs and to utilize scientific knowledge. These needs are linked with scientific knowledge by means of a rationalized, problem-solving system. Fourth, as a system, knowledge-production-and-utilization consists of both structure and process; and this point is judged to be so important in our conceptualization of knowledge that we introduce the six-stage model with an overall "perspective" on the system which incorporates structure and process into one theoretical framework. The structural elements include the goals, status-roles, and boundaries of the system, participants and subunits. In the model, different stages and steps in the system are distinguished. As a process, knowledge-production-and-utilization consists of the activities performed in achieving system goals, and these may be differentiated into the general stages and specific steps in the model. Thus, the model simultaneously attempts to depict the structure and process of knowledge-production-and-utilization, rather than one or the other. Fifth, as Rogers and Jain say, the critical process in knowledge-production-and-utilization is communication or the exchange of information from sources to receivers at many points along the knowledge-production-and-utilization chain. Indeed, the key to effective utilization is the communication of planned messages that will permeate the various structures inhibiting utilization. To say it in another way, communication aims to "unfreeze" the knowledge locked within system structures. Lastly, the process of knowledge-production-and-

utilization is iterative rather than linear; in most cases, it ends with the client but it may start anywhere on the knowledge-production-and-utilization chain. Each of these points will be clarified and expanded in the course of this presentation.

This then, appear to be six critical elements of the knowledge-production-and-utilization process. They form the basis for our present working definition of knowledge-production-and-utilization:

> a communication system in which the knowledge generated by scientists, clients, and other system-participants is systematically incorporated into the design, production, adaptation, and dissemination and use of technologies, products and programs to meet client needs.

This definition departs somewhat from others in the priority it attaches to utilizing (or at least accounting for) the intuitive, common sense, empirical and technical knowledge from <u>all</u> participants in the knowledge-production-and-utilization chain in addition to the systematically-verified knowledge of scientific research.

B. A Brief Historical Review

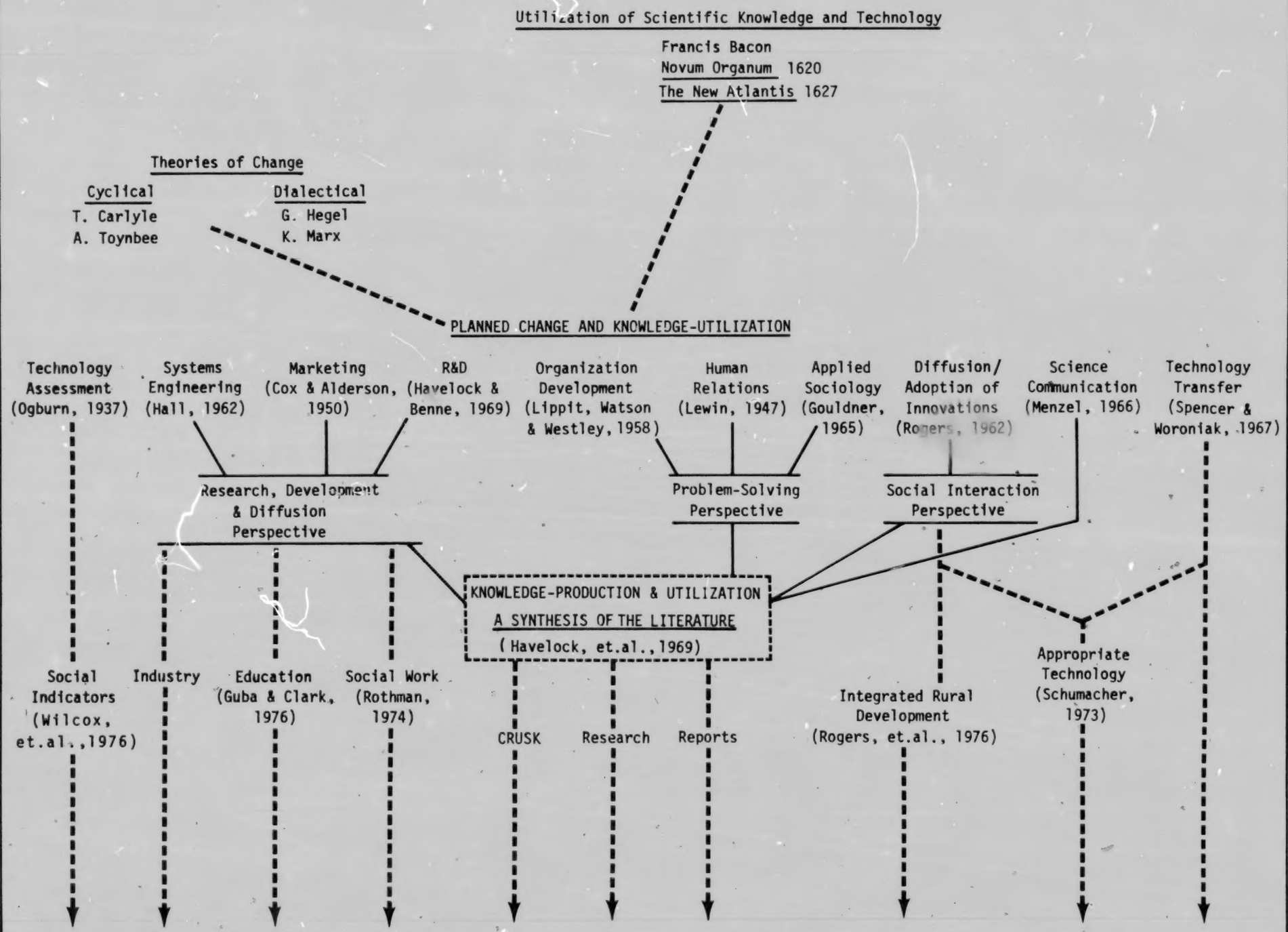
As noted in the historical chart of knowledge-production-and-utilization theory (Chart 1), we trace its beginnings to Francis Bacon's Novum Organum and New Atlantis. Bacon specified few details on the operation of the process but he did introduce the idea that the fruits of his experimental method could extend far beyond the laboratory in which they were created. Havelock traces the beginnings of concern with the process to Carlyle's cyclical and Marx's dialectical theories of change in the nineteenth century (1969:10-11). He sees these influences emerging later with the idea that changes could be planned for the improvement of people and organization in society.

In an early article on planned change through organization development, Mann and Likert (1952) discussed the need for utilizing knowledge from social research for effecting such change. Scholars from various disciplines studied different aspects of the process through the 1950's (Likert and Hayes, 1957) and early 60's (Rogers, 1962); and by the mid-60's, a small group of social scientists and educators had begun to focus on knowledge-production-and-utilization as a distinct field of study (Eidell and Kitchel, 1968).

In 1969, after reviewing 4,000 articles dealing with planned change, Havelock (1969) delineated three research perspectives which underlay knowledge-production-and-utilization as a distinct field of study. First, the Research, Development, and Dissemination (RD&D) Perspective emphasizes the logical flow of scientific research from the research laboratory or university to developers for conversion into technologies which are then disseminated or marketed to

CHART 1

HISTORICAL DEVELOPMENT OF KNOWLEDGE PRODUCTION & UTILIZATION AS A SPECIALIZED FIELD OF STUDY



consumers. Although Havelock (1969:11-17) believes the RD&D approach is "overly-rational, over-idealized, excessively research-oriented and inadequately user-oriented," he feels it indicates several important characteristics of the process: high initial cost of development, the need for large-scale planning, and a division of labor.

Second, the Social Interaction Perspective, derived largely from the diffusion/adoption-of-innovation literature, emphasizes the importance of social relations and reference groups which affect individual users' adoption of products. In its focus on diffusion, however, it offers little insight into research and development phases. Thirdly, the Problem-Solving Perspective draws largely from the human relations/group dynamics literature and assumes that "knowledge-utilization is a part, and only a part, of a problem-solving process inside the user which begins with a need and ends with the satisfaction of that need" (Havelock, 1969:10-55). This explicit client-orientation emphasizes the use of internal as well as external knowledge resources.

C. Theoretical Approaches

1. A Linkage Approach

Havelock integrates the RD&D, Social Interaction, and Problem-Solving perspectives into a single "linkage model" of knowledge-production-and-utilization.

> Linkage is seen as a series of two-way interaction processes which connect user-systems with various resource systems, including basic and applied research, development, and practice.... Hence, the resource-systems must appreciate the users' internal needs and problem-solving patterns, and the user, in turn, must be able to appreciate the invention, solution-formulation, and evaluation processes of the resource systems.... These trust relationships can over time, become channels for the rapid, effective and efficient transfer of information (Havelock, 1969:11-15).

The key to linkage is the understanding of user needs by resource-systems and understanding of resource-system needs by users. This mutual understanding clears the way for more effective communication between user and resource. Havelock specifies four basic linking processes in his problem-solving model (Figure 1) of knowledge-production-and-utilization: 1) articulation and transmission of client needs; 2) production and development of solutions to client problems; 3) transfer of relevant solutions to clients; 4) adoption and utilization of new inputs by the client system to solve his/her problems. Havelock's "elaborated framework" of the same, basic model (Figure 2) is of interest to us because it begins to break down the linkage process into its functional elements. The functions are presented in two-major need-processing and solution-processing flows. The four-stage, need-processing flow approximates Lazarsfeld and others' (1967) concept of "translation" which calls for conversion of client problems into the concepts, measures, and propositions of science. Researchers then are able to study and perhaps understand the way in which

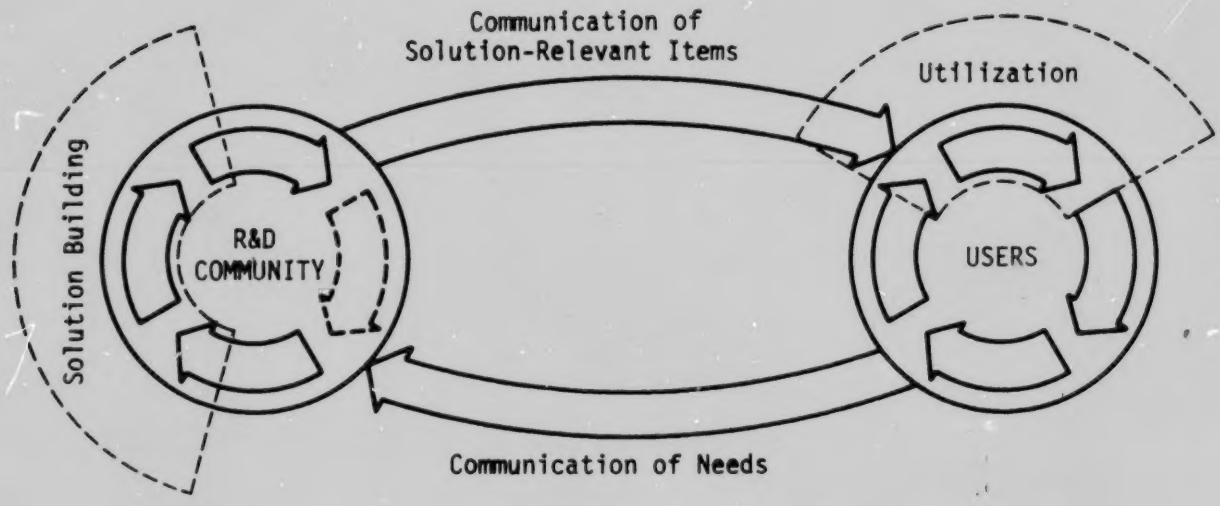


Figure 1. A Problem-Solving Model of Knowledge-Production-and-Utilization

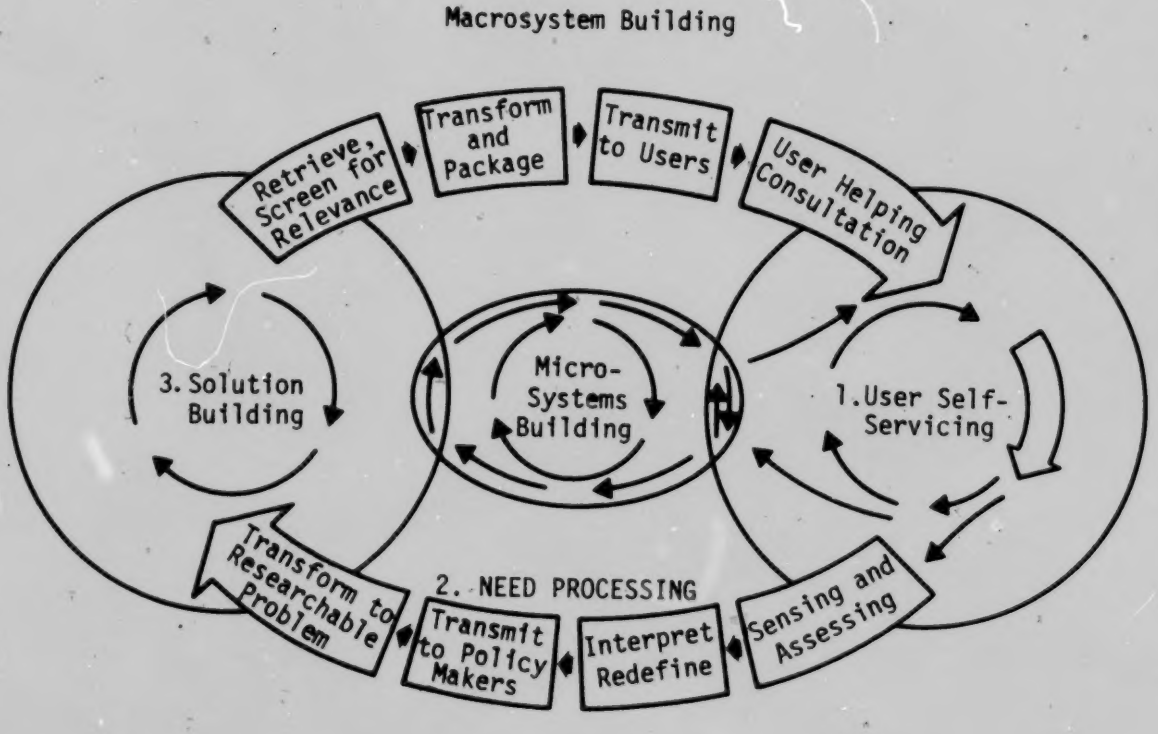


Figure 2. An Elaborated Framework of the Problem-Solving Model

variables interact to cause a problem. The result of scientific research, then, is understanding of the problem and its causes and this understanding is used to create a solution to the client's problem. The result is a "problem-solving dialogue" in which user-resource linkage is the essence.

2. A Configurational Approach

Guba and Clark's "configurational perspective" (1975) aims explicitly to achieve completeness, balance, and realism in a broad conceptualization of knowledge-production-and-utilization in the field of education. In doing so, it emphasizes structural and processual elements of knowledge-production-and-utilization and attempts to rectify shortcomings of previous conceptualizations. First, it approaches completeness in its recognition of the basic stages of knowledge-production, development, diffusion, and adoption. Second, it seeks balance in its dual focus on general and specific problems and solutions. Third, it moves toward realism in its conceptualization of knowledge-production-and-utilization as a community. This community consists of people and organizations who

> may from time to time find it helpful to form temporary alliances, but who, in the main, retain their independence, shun authority, and activity relationships, and engage in as many different kinds of knowledge-production-and-utilization activities as seem to be needed and feasible for them to maintain their self-sufficiency (Guba and Clark, 1975:9).

This conscious recognition of personal, organizational and structural factors which affect a seemingly smooth knowledge-production-and-utilization process lends realism and conceptual strength to the configurational perspective which is not so apparent in other approaches.[1] Thus, while "the

[1]This point is consistent with Archer and Korstetter's (1967) call for recognition of "the human element" in knowledge-production-and-utilization which thwarts so many well-laid plans.

configurational view" assumes that the educational knowledge-production-and-utilization community "encompasses the full range of diverse institutions and individuals involved in the social process field of education" at the same time, it "is cognizant of and endeavors to account for the full range of knowledge-production-and-utilization functions...however grouped and with no assumption of linear flow" (Guba and Clark, 1975:8).

This "full range of functions" was described earlier by Guba (1968) in a four-stage model[2] which we present here for three reasons. First, similar to the RD&D perspective and Havelock's "elaborated framework," the model aims to conceptualize the systematic, step-by-step process of knowledge-production-and-utilization. Second, it achieves a balance between complexity and simplicity that makes it pedagogically useful. Third, it acts as a prototype for the linear, static model of knowledge-production-and-utilization which presented in the following section.

Guba's model (Figure 3) consists of four basic stages--research, development, diffusion, and adoption--and each stage includes at least three steps.

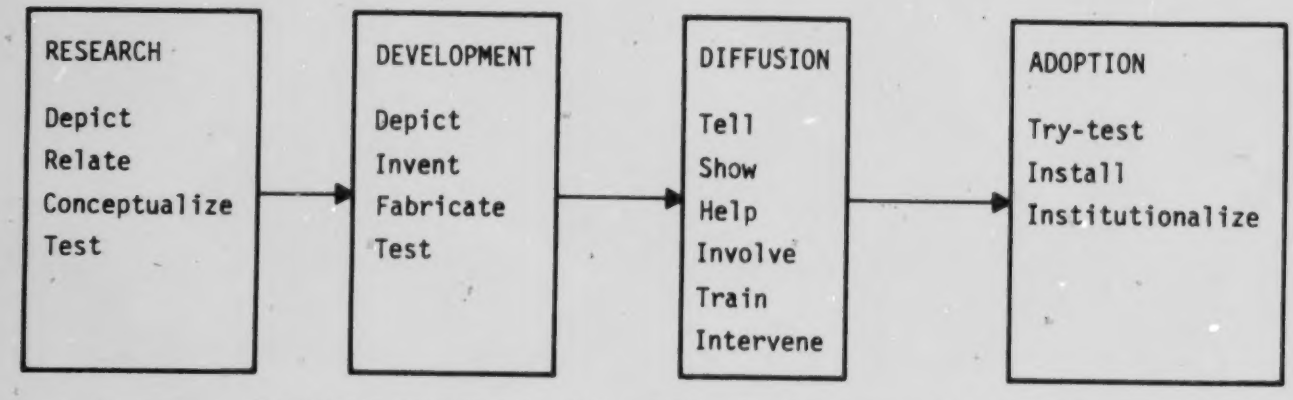


Figure 3. The Clark-Guba Model of Knowledge-Production-and-Utilization

[2]The model was presented originally by Guba and Clark and is known as the Guba-Clark Model.

Briefly, research functions to produce verified knowledge according to the scientific method of depiction, relation of variables, conceptualization, and testing. Development monitors client problems and depicts those problems of relevance to the development sub-system. Solutions to those problems are invented and then fabricated and tested. Completed solutions (e.g., products, programs, or technologies) are diffused to potential users and some of these are adopted. Users generally try-test innovations before installing and finally institutionalizing them. This four-stage model is believed to provide the analyst with a stronger cognitive hold on the elusive, extremely varied functions which compose the knowledge-production-and-utilization process.

Gideonse suggests, however, that the Guba-Clark Model is deficient in its implication of a linear flow of activity from research to adoption. The model

> does not emphasize sufficiently that initiative for different kinds of actions can take place at any point in their continuum and that these initiatives may come from locations other than where the action itself is to be performed. The model unwittingly implies that innovations begin with the findings generated by fundamental research (Gideonse, 1968:541).

We consider this point of critical importance and feel this non-linear emphasis, to a large degree, explains our preference for the term "knowledge-production-and-utilization" as compared with "research-production-and-utilization. The importance of scientific knowledge from research is recognized as an important input to the solution of many problems. However, knowledge from many sources and actors - especially ultimate client/users - in the production-utilization chain can make valuable knowledge contributions to problem-definition, solution-development, dissemination and use.

It may be noted that Guba and Clark rectify this problem of linearity in their later configurational views. Further, although they describe their "balance" criterion in terms of the general/particular distinction, we feel the configurational view is just as valuable in its balance of structure with process. The configurational perspective is a theoretical portrayal of process working through structures; and we believe this focus is critical for a complete, balanced, and realistic understanding of knowledge-production-and-utilization. The practical value of such a perspective is explained by Guba and Clark:

> Unless the extant structure of the field is taken into account, and unless the legitimate interests of the individuals and agencies that populate the domain of educational knowledge-production-and-utilization are honored, there will be no significant progress in the development of long-range, effective policies of knowledge-production-and-utilization (1975:9).

In summary, elements of the configurational perspective - particularly its incorporation of structure and process into a single conceptual framework - help to define a fruitful approach to knowledge-production-and-utilization. We incorporate a number of these elements into our own working model.

3. An Iterative, Output-Oriented Approach

Gideonse has presented a model of knowledge-production-and-utilization which emphasizes its iterative character and the outputs products in each stage of the process. First, the model assumes that the source of initiative for starting the process may arise anywhere in the knowledge-production-and-utilization chain rather than only at research. Gideonse's model

> implies that while there is a strong logical flow from the production of knowledge through the development of processes to their installation in operational settings, these may be just as strong backwards as operational problems define development programs, which in turn, reveal the need for certain basic information and theory (Gideonse, 1968:544).

Unlike the linear approach, this iterative approach to knowledge-production-and-utilization holds that knowledge and its products may move back and forth from one step or stage to another rather than always flow smoothly from one end of the utilization chain to the other.[3] Carter finds evidence supporting this approach in his study of technology-development in the United States Defense Department:

> The study clearly indicates that an orderly process from research to development to use is largely a myth that, in fact, there is a great deal of crossing back and forth in terms of the development cycle, funding, and people involved (1968:6).

Nadler builds an iterative element into his "design approach" to industrial product development: "The division line between each step is not clear. Some parts of a system may require movement forward to a later step while retrogression to former steps may also be required" (1967:B-648).

Second, Gideonse's model recognizes the potential importance of "linkage" problems as it conceives of the different stages as

> distinct kinds of activities with quite different objectives or outputs.... Initiatives for each kind of activity are the results of decisions based on different kinds of data and equally distinct kinds of internal and external needs (1968:541).

To bridge the gap between these various activities, Gideonse introduces the important concept of "transition requirements."

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[3] An iterative process is marked by repitition and recurring action rather than a smooth flow from a starting-point to an end point.

> The notion that there are obligations on both research and development to transfer their 'products' to other activities means that each must pay careful attention to the way in which its outputs are presented, and, perhaps the very way in which the outputs are produced. In other words, the requirement that eventually there be transfer or incorporation into another type of activity places constraints upon the professional behavior in each activity which cannot be ignored without compromising later impact. If transition requirements are not provided the developer may well have rendered his product unusuable (1969:543).

In other words, while all participants must perform their specialized functions in the knowledge-production-and-utilization process, they must also provide inputs which facilitate the assimilation of outputs by others in the chain. Thus, "the researcher who publishes perfectly valid findings in a sloppy or difficult format...thereby hinders the likelihood of their being incorporated ultimately into practice" (Gideonse, 1968:543). In our model, the "packaging" step in all but the adoption/utilization stage is an explicit recognition of these "transition requirements."

Third, Gideonse's model emphasizes the outputs produced in each stage of the process. In doing so, it "forces the viewer to consider what the outputs of each activity are and to think about how they are of use to one another" (1968:544). This output-orientation is significant as it focuses attention on the fact that outputs of each stage are produced for the purpose of utilization in other stages; and this fact places demands on production which Gideonse makes abundantly clear in the concept of "transition requirements."

D. Conclusion

The linkage, configurational, and iterative/output-oriented approaches to knowledge-production-and-utilization both introduce and lay the foundation

for our own model presented in the following section. In particular, they indicate the need for: 1) breaking down the process into stages and steps in order to understand its operation; 2) simultaneously focusing on structural and processual elements of knowledge-production-and-utilization; 3) constructing an iterative, non-linear model of the process; 4) realizing that initiative for starting the process may occur at any point on the knowledge-production-and-utilization chain; 5) utilizing, or at least accounting for, the knowledge-contributions of system-participants at each stage of the process, rather than contributions from scientific research alone; 6) building communication linkage and meeting transition requirements within and between each stage; and 7) considering the outputs generated at each stage of the process.

We move now to the presentation of a general model of knowledge-production-and-utilization.

III.

A GENERAL MODEL OF KNOWLEDGE-PRODUCTION-AND-UTILIZATION

In this section, the process of knowledge-production-and-utilization is presented in two forms - a static model and two iterative, dynamic flows. The static model portrays an orderly movement of knowledge from production through four middle states to adoption/utilization: whereas two iterative, dynamic flows serve to illustrate the complex interaction between stages which is likely to occur under actual conditions.

Three aims guided construction of the static model, namely: completeness, specificity, and pedagogical clarity. First, by completeness is meant that the model seeks to account for all the operations existing in the most comprehensive knowledge-production-and-utilization system. Second, specificity means that each stage is broken down into specific (a minimum of seven) steps and each step is explained in some detail. Third, the static model -- compared with the iterative, dynamic flows -- is a useful pedagogical tool as it presents the stages and steps in one logical sequence and enables the observer to establish a context for following the more complex interaction of the iterative, dynamic model. The models are "general" in the sense that they are proposed for application at all personal and organization levels and for all types of knowledge. Thus, they include knowledge-production-and-utilization which occurs in a wide range of situations, such as: organizational development consultancy, individual counselling, mass-production and marketing of commercial goods, social work, and international technology transfer. The models assume the utilization of social, as well as material, technologies and products.

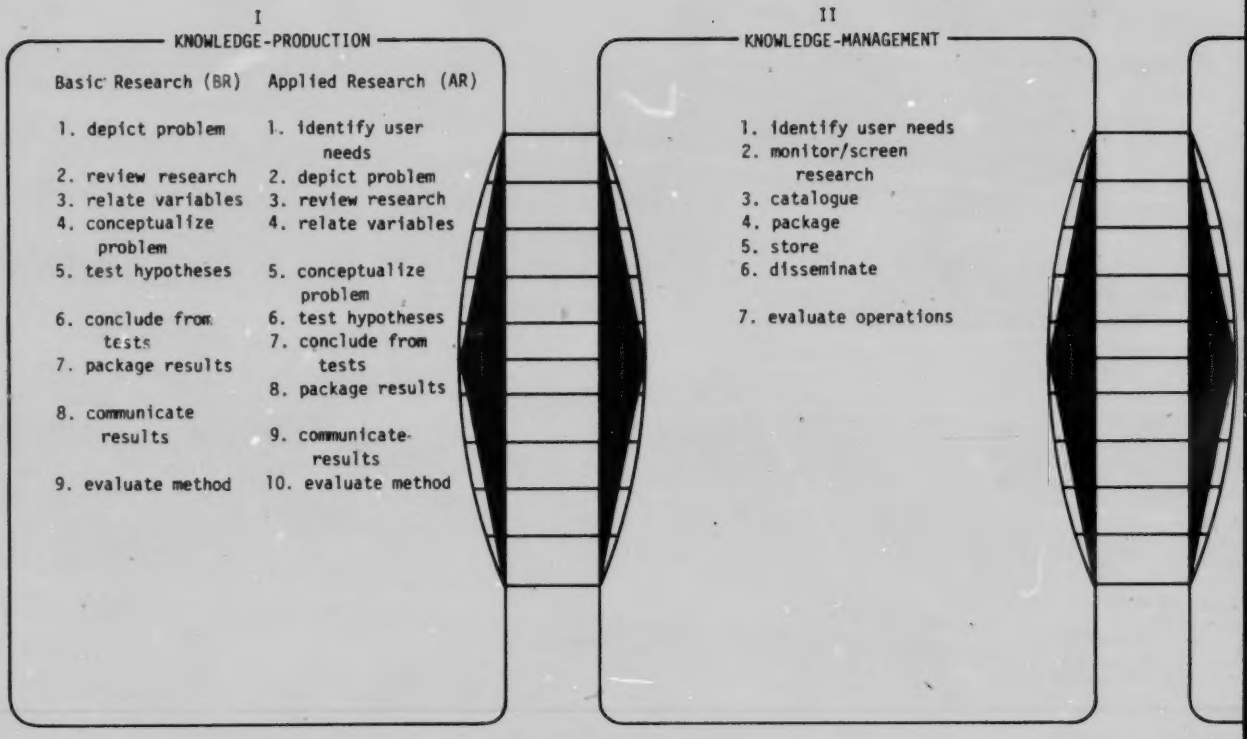
A. The Static Model

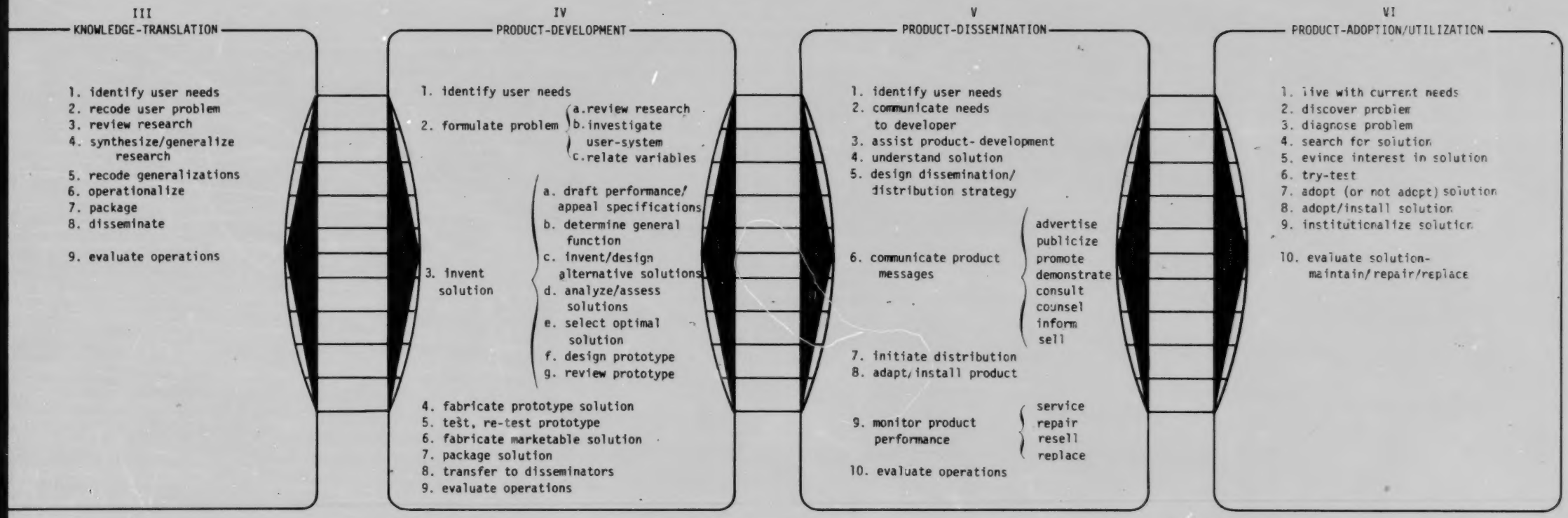
In this section, knowledge-production-and-utilization is, so to speak, placed under a microscope, dissected into its component parts, and then re-integrated into a complete system.

Guba (1968) delineated four stages--research, development, diffusion, and adoption--in his model, and added an information stage between research and development in a later model (1970). In contrast, Gideonse portrayed his model in three stages - research, development, and operations. We distinguish six stages in our model of knowledge-production-and-utilization. We believe there are six sets of operations sufficiently distinct in their processes, products, and activities to merit division into six stages. The stages are: knowledge-production, knowledge-management, knowledge-translation, product-development, product-dissemination, and product-adoption/utilization (Figure 4). In this paradigm, knowledge becomes a product when it is developed into a social or material technology for utilization by clients. We present the model by first describing its six stages at a general level and then describe the detailed steps within each stage.

1. Six Stages of Knowledge-Production-and-Utilization

Knowledge-production. Knowledge is produced primarily through basic and applied research conducted by scientists in the public and private sectors of society. The goal of knowledge-production is the advancement of knowledge of the physical and social worlds and its main products are scientific concepts, hypotheses, propositions, theories, and descriptive data. More specifically, scientists aim to produce knowledge in the form of verified statements of


I
KNOWLEDGE-PRODUCTION
Basic Research (BR)
1. depict problem
2. review research
3. relate variables
4. conceptualize problem
5. test hypotheses
6. conclude from tests
7. package results
8. communicate results
9. evaluate method
Applied Research (AR)
1. identify user needs
2. depict problem
3. review research
4. relate variables
5. conceptualize problem
6. test hypotheses
7. conclude from tests
8. package results
9. communicate results
10. evaluate method
II
KNOWLEDGE-MANAGEMENT
1. identify user needs
2. monitor/screen research
3. catalogue
4. package
5. store
6. disseminate
7. evaluate operations



A GENERAL MODEL OF KNOWLEDGE-PRODUCTION & UTILIZATION

(Figure 4.)

relationships between and among variables. These statements are presented to various publics in journal articles, research reports, and conferences.

Opinions differ about the need to distinguish between basic and applied research. Guba's research stage, for example, involves only basic research: "The researcher is not concerned, nor should he be, with whether or not his research has an evident practical application" (1968:42). Gideonse, on the other hand, distinguishes between the two according to "the purposes for which they are generated" (1968:544). Thus, while basic research is produced for its findings alone, "applied research is also supported for the knowledge which results from it, but the initiator of the research knows to what instrumental use he is going to put the findings" (1968:544). A number of scholars and practitioners, particularly in the social sciences, have criticized knowledge-producers for emphasizing basic research to the exclusion of applied research (Gouldner, 1965; Handler, 1969; Beal, 1969; Roling, 1973; Stankey, et al., 1975). For example, Roling (1973), discussing agricultural development, states the need for "problem-solving research" in which the goal is "not to gain knowledge which improves theory but rather to gain knowledge which can improve the outcome of a project, i.e., knowledge about effective means to achieve a desired state or objective" (1973:23).

Other scholars differ in their estimation of the relationship between basic and applied research. Etzioni and Remp (1973:198) have said they are "two semi-autonomous activities which interact with one another". Carroll, in the field of education, has characterized their relationship as complementary. On the one hand, applied research can test "basic science knowledge in its application to a specific, practical goal" (Carroll, 1968:272-273). In this way, one builds upon the other to create new knowledge. A somewhat

different view is presented by Marquis and Allen (1966) in their studies of industrial research and development. They conclude that basic science and "technology" (applied research, exploratory development, and engineering)

> advance quite independently and much technology advances without a complete understanding of the science upon which it is built. Occasionally, technology encounters a problem blocking its advance, the removal of which requires a fundamental understanding of the scientific basis of the phenomena involved (1966:605).

In his study of the British chemicals industry, Langrish goes so far as to say that:

> New products and processes of industry seem to depend on a combination of existing technological concepts, economic pressures, and empirical research with basic scientific understanding not being relevant (1974:616).

Thus, the relationship between basic and applied research and the nature of their contributions to the knowledge-production-and-utilization process do not appear to be clear-cut.

In summary, the main distinctions between basic and applied research may be in their goals and uses. Basic research aims to understand phenomena while applied research aims to change phenomena in order to meet the needs of clients. Thus, basic research is used primarily to stimulate further research while applied research is used by developers, disseminators, and clients to solve practical problems. In a general sense, basic research "stays within" the research community and applied research is more likely to enter other client-systems. We incline toward the interpretation of basic and applied research as semi-autonomous activities and consider distinctions between them sufficiently important to separate them in the knowledge-production stage. Similar to Carroll (1968), we feel that one should have a complementary relationship with the other and that effective

management of this relationship is one important means of improving the efficiency of the entire knowledge-production-and-utilization process. As stated earlier, in the social sciences in particular a number of writers point to the imbalance of basic over applied research and state the need for significant advances in applied research theory and methodology. In particular, the applied social scientist should focus on manipulable variables over which the policymaker, developer, and ultimate user can exercise a major degree of control. Recognition of this early in the knowledge-production stage may greatly enhance eventual utilization of research.

Knowledge-Management. The outputs of the knowledge-oroduction stage are research publications presenting methodology, descriptive data, and explanations of relationships between and among variables. In the knowledge-management stage information from these publications is then collected, sorted, and stored. Knowledge-managers also inform clients of available research in the form of indexes, abstracts and bibliographies, and they provide clients with easy access to the available knowledge. Primary users of "managed knowledge" are knowledge-producers and translators, and managers must know their specific client-system in order to package their output according to client needs. The literature of science communication (Menzel, 1966) provides knowledge-managers with extensive information on the communication patterns of scientists. The ERIC system in education is one knowledge-management agency. Kiehl (1970) states the case for a nation-wide, computerized knowledge-management system in agriculture.

Knowledge-Translation. Following the management stage, scientific knowledge is translated into a form useful in product-development. There are two types of translated knowledge which we call delimited scientific knowledge and technological knowledge. Delimited scientific knowledge consists of scientific generalizations narrowed to "more finite specifications of locations, contexts, and behaviors" of variables (Rothman, 1974:538). This knowledge facilitates understanding and formulation (Step IV-2, Figure 4) of specific client problems in the development stage. Nelson defines technological knowledge as "a set of techniques each defined as a set of actions and decision rules guiding their sequential application that man has learned will generally lead to a predictable outcome under specified circumstances" (in Short, 1968: 276). This knowledge guides developers in the design and fabrication of technologies.

The actual process of translation involves synthesis and generalization of research knowledge in areas of interest to developers and conversion of this knowledge into terms and guidelines useful in product-development. Output of the translation stage consists of packaged information, guidelines, and operational rules for use in the creation of solutions to client problems. Rothman calls this stage "translation, conversion, and operationalization" (1974) and Mackie (1974) calls it "collation, interpretation, and translation." Guba (1970) describes this as the information stage and Havelock presents several examples of translation-roles in his analytical models (1974). Short (1968) and Quetzkow (1959) also discuss knowledge-translation.

Product-Development. Technical knowledge produced in the translation stage is then utilized to create technologies in the development stage. The National Science Foundation has defined development as "the systematic use of scientific knowledge directed toward the production of useful materials, devices, systems or methods, including design and development of prototypes and processes" (in Spooner-Smith, et al., 1973:2). Development is client-oriented and has three broad functions: identification of client problems, formulation of solutions to these problems, and fabrication of solutions. It is a "cyclical trial-revision process" that may continue indefinitely as products are improved or replaced over time (Schultz, 1967).

Product-Dissemination. Following development, products are disseminated to clients or ultimate users. Guba describes dissemination as "the creation of awareness about new developments and the provision of opportunities for their assessment" by users (1968:42). Kotler and Zaltman present a somewhat different view in their "social marketing" approach. Here, "most of the effort is spent on discovering the wants of targets audiences and the creation of goods and services to satisfy them" (Kotler and Zaltman, 1971:5). The approach to dissemination employed in this report calls for close collaboration between developers and disseminators in the fulfillment of five main functions: discovery of client needs, assistance in product-development, creation of messages to inform potential clients of the product, product-distribution and product-installation and maintenance.

Product-Adoption/Utilization. Product-adoption/utilization consists of the process by which clients discover problems, locate solutions to the problems, and assimilate solutions into their existing systems. Schutjer and Van Der Neen (1976:42) dealing with agricultural technology, distinguish between mere adoption and effective utilization of new technologies. In

the same vein, Guba discusses "institutionalization" of products (1968: 50). These points will be discussed more completely in the following section. The end-result of the adoption/utilization stage and of knowledge-production-and-utilization, in general, is the solution of client-problems.

2. Steps in the Stages of Knowledge-Production-and-Utilization

Presentation of the general stages of knowledge-production-and-utilization provides a basis for a more detailed discussion of the steps within each stage (Figure 4). In this section, each step is explained and some of the conceptual gaps and weak points are indicated.

Knowledge-Production. Knowledge-production consists essentially of the process of depicting and testing relationships among and between selected variables and then communicating results of these tests to relevant audiences. Most knowledge is produced through basic and applied research, and we distinguish between these types of knowledge-production according to: their purposes, kinds of variables studied, methodology, and methods of dissemination. First, whereas basic research aims primarily to advance understanding of social and material phenomena, applied research aims to increase understanding of phenomena in order to change those phenomena. Second, basic research tests the interaction between selected variables under controlled and, in many cases, laboratory conditions, while applied research tests variables primarily in "real-world" or field conditions.[4] Further, the applied research tries to select variables

[4] In his discussion of studies with high and low "application potential," Mackie (1974) presents this trade-off to the researcher: less experimental control may mean higher applicability but it also may mean less specific delineation of cause-effect relations among variables. Roling (1973) makes a strong case for applicability in the social scientific study of small-farmer development.

capable of manipulation by clients to solve their problems. Third, differences in methodology arise largely from the use of different types of variables tested and environments in which testing is done. Fourth, basic researchers disseminate their findings primarily to scientific colleagues through journals, books, and conferences while applied researchers may present their findings to various categories of clients in written or oral reports and training sessions as well as in professional or academic journals and in more "popular" media. In general, basic research products will be used primarily at the knowledge-production and management stages while applied research is more likely to be used in any stage to solve operational problems. The importance of these distinctions between basic and applied research lay in the fact that applied research appears, by its nature, to possess a high capability for application to problems. Because of this, efforts to increase the application potential of knowledge in the production stage should focus more specifically on applied rather than basic research.[5] Although this point appears obvious, it is not always made clear in the literature of knowledge-production.

With these distinctions in mind, we delineate nine steps in the process of basic research and ten in applied research. Applied research begins

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[5]Mackie (1974) presents seven criteria for judging the "application potential" of social research: motivation of the researcher, criteria for task selection, types of stimuli in the experiment, types of response to stimuli, motivation of subjects, time allowed for experimentation, and environmental effects.

with the identification of clients' needs (Step I (AR)-1, Fig. 4) and these needs set the parameters within which the investigator works. Clients (who may be product-developers or disseminators, as well as ultimate users of products) may reveal their needs to researchers in the course of sample-surveys, participant-observation, personal interviews, or a variety of other means.

Following need-identification, the researcher converts the need into a depicted problem (Step I (AR)-2) or "general description of the phenomenon of interest" (Guba, 1968:43). Similarly, the basic researcher engages in problem-depiction (Step I (BR)-1) except that these problems arise not from clients' needs but from the researcher's own interests, his/her discipline's priorities, or from empirical situations. Applied and basic researchers usually review literature (Step I (BR)-2; I (AR)-3) related to the problem in order to discover conclusions of researchers who studied the problem previously. In the course of this review and further depiction, the investigator isolates and relates selected variables of importance (Step I (BR)-3, I (AR)-4) until, finally, the problem is conceptualized (Step I (BR)-4, I (AR)-5) in a framework suitable for testing. Conceptualization "attempts to account for the observed depictions and relations" and a "sufficiently-developed network of relationships makes it possible to suggest reasons for them" (Guba, 1968:44). Here, one of the crucial differences between basic and applied research may become evident. The applied researcher--whose ultimate aim is to solve a practical problem rather than advance knowledge--often selects variables which can be controlled or at least manipulated in practice. Thus, Mackie's review of knowledge-

production-and-utilization in psychology led him to conclude that studies having "high application potential can be designed if the researcher adopts as his point of departure a thorough understanding of an operationally meaningful behavioral problem" (Mackie, 1974:17). This point of departure for the applied researcher is problem-depiction and carries through the entire knowledge-production stage.

Following problem-conceptualization, the basic researcher tests the hypothesized relationships between variables in a controlled setting (Step I (BR)-5) while the applied researcher tests these relationships in a "real-world" setting (Step I (AR)-6). Both investigators compare the degree to which observed interaction of variables "fits" the hypothesized interrelations and from these comparisons, they draw conclusions (Step I (BR)-6; I (AR)-7) about the behavior of phenomena. In this way, basic science increases one's understanding of phenomena and applied science both increases one's understanding and the ability to change phenomena.

Conclusions and supporting evidence from basic and applied research are then packaged for dissemination (Step I (BR)-7; I (AR)-8). This step in the knowledge-production stage is especially crucial for purposes of utilization. Packaging requires that scientists become skilled communicators; that is, they should understand their audience and present their conclusions in a format and terminology which facilitates maximum comprehension by users. In the case of basic research, most users will be other scientists and communication will occur primarily in academic journals and meetings. Applied scientists, however, are more likely to package results for anyone

on the knowledge-utilization chain.[6] For this reason, communication will occur in a variety of forms (e.g., personal interviews, group meetings, and written reports as well as publication for academic journals), and will require a battery of effective communication skills. Caplan in a study of 575 instances of social science information-utilization by high-level, government policy-makers, concludes that "indirect" rather than direct communication may be needed most in the present relationship between applied social scientist and policymaker:

> Increased production of objective and policy-relevant data, and further development and improvements in knowledge storage and retrieval systems, are unlikely to advance utilization unless accompanied by success in influencing the policy-maker's understanding of the problem he faces, increasing awareness of what he needs from research, and increasing his willingness to balance scientific and extra-scientific considerations.... As a single step, what is needed to increase the level of utilization is to bridge social science and policymaker perspectives, but not necessarily increasing the amount of direct contact between social scientists and policymakers themselves (Caplan, 1975:23).

The eighth step of knowledge-production is a two-fold evaluation (Step I (BR)-9; I (AR)-10). First, investigators should evaluate their research theory and methodology to discover sources of statistical bias, evidence of unfounded assumptions, and other methodological problems.

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[6] Lionberger and Reddy distinguish between "academic communication" within the scientific community only and "extension communication" with non-academic professionals, practitioners, and clients. After interviewing 125 social science faculty members at the University of Missouri, they concluded that:

> "extension productivity is highest when supported by perceived strong reference group influence from colleagues in government and industry, plus either the general public or the university administration. Conversely, highest productivity was associated with weak perceived influence from own academic discipline" (Lionberger and Reddy, 1976:38).

One method of increasing the amount and utilization of applied research may be to facilitate the impact of particular reference groups on certain university researchers.

Second, the packaging step should be evaluated according to selected criteria of communication-effectiveness. Effectiveness of applied research is measured ultimately by the degree to which it helps to solve a practical problem. Communicators in basic research can also evaluate their effectiveness by assessing the degree to which colleagues understand their research results.

In conclusion, the output of the knowledge-production stage is knowledge generated from basic and applied research and communicated to a variety of users through journal articles, personal presentations and other means. Because results of basic research appear only rarely to move outside the research community it appears that efforts to increase the contribution of basic research to the solution of practical problems should concentrate primarily on the packaging of research results for utilization by applied researchers, knowledge-managers, and translators. To repeat, "the basic researcher is not concerned, nor should he be, with whether or not his research has an evident practical application" (Guba, 1968:44). The applied researcher and, to some degree, managers and translators are concerned with practical application, however, and effective packaging of basic research results may facilitate its utilization.

Improvements in the ability of applied research to solve practical problems can be made in virtually every step of knowledge-production. For example, in the problem-depiction step, applied researchers can focus on client needs for which their analytical tools are capable of providing a solution.[7] Similarly, in the depiction, relation, and

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[7] Street and Weinstein (1975:72) consider this to be particularly important in applied sociology: "Sociologists will not do good applied work until they recognize and communicate the limits as well as the potentials of what they are doing."

conceptualization steps, they can concentrate on those particular variables capable of manipulation. In the testing step, they can test the interaction among variables in conditions similar to those in which the solution is needed rather than in controlled conditions. Lastly, in the packaging step, applied researchers can understand their various audiences and present their data, conclusions, and recommendations in an appealing, easily-understood manner.

Knowledge-Management. The main physical output of knowledge-production is a vast amount of reports, papers, articles, and books presenting research findings. If maximum utilization of these publications is to occur, they need to be collected, ordered and disseminated among interested users. This is the job of knowledge-management and its traditional symbol is the library. However, increasingly sophisticated computer technology has changed the role of the library over the past thirty years and created new types of knowledge-management services to serve more diverse, complex user needs.

The first job of knowledge-management is to identify its clients (Step II-1, Fig. 4) and their information needs. In most cases, knowledge-producers and translators (stage 3) will be the primary users, but personnel from any stage of the process may require these services. When user needs are identified, managers will know the types of research to monitor and can develop criteria for screening this research (Step II-2). Although the job of monitoring appears relatively passive, it requires the initiative to seek out pertinent sources of information and maintain relations with many publishers, editors, scholars, and others in the knowledge-production industry. For example, the Medical Literature of Medicine

receives 18,000 to 19,000 serials annually although only 2,200-2,300 are indexed and stored (Havelock, et al., 1974:365). Short (1973) says that an important job of the research-monitor is simply to gain access to findings considered important.

Screening consists of the process by which monitored research is reviewed and selected for storage according to specified criteria. These criteria depend primarily on user needs and include: content relevance, age of research, format quality and, in fewer cases, content quality and sales potential (Havelock, 1974:331). Rothman screened research according to its reliability, validity, and applicability for social work practitioners (1974:537). Thomas (1967) employed similar criteria in his selection of social work literature according to knowledge power (validity and predictive power), content relevance, and referent features (identifiability and manipulability of variables in social work contexts).

Screened research is then reviewed, indexed, and catalogued (Step II-3) under descriptors selected according to research content and user categories. Each knowledge-management system creates its own thesaurus of terms, and the importance of the thesaurus is evident in the fact that the success of users' bibliographic searches depends largely upon the accuracy and reliability of descriptors employed. An interesting finding of one study is that

> with the exception of the Congressional Research Service of the Library of Congress no knowledgement system has attempted to index material in user terms rather than in inputers' terms, e.g., by creating some sort of problem index. Therefore, most systems may be more geared to the needs of researchers than of practitioners (Havelock, et al., 1974:333).

It is logical that researchers should draw heavily upon managed knowledge in their literature reviews (Step I (BR)-2; I (AR)-3); as a result, it is not surprising that much of the cataloguing is done in researchers' terms. However, this situation throws into relief a central problem of the entire knowledge-production-and-utilization process, namely; when and how to convert abstract, scientific concepts and propositions into terms useful to practitioners and clients in the solution of practical problems. One alternative is to convert descriptors into practitioners' terms in the knowledge-management stage; and another is to make this conversion in a later stage which we call "knowledge-translation."

Catalogued research is then packaged and stored (Steps II-4 and 5) in the form of microfilm and printed matter. Articles, bibliographies, books, and abstracts on microfiche are transformed into machine-readable form by specialized typists while printed matter is reproduced and filed. Thus, the primary job of packaging is to determine the form in which catalogued research should be prepared and this depends, once again, on the type and degree of user-demand.

Storage is the process of maintaining packaged research over a period of time primarily on microfilm and in collections of printed matter. If one conceives of this as a "banking" function, the dynamism involved in this process becomes clearer - materials must be entered, disseminated, and replaced as the supply and demand for them rises and falls.

Dissemination of stored research (Step IV-6) is a crucial knowledge-management step because it is here that the "pay-off" of management--the "sale" of information to users--occurs. A dissemination plan should encompass each step in the knowledge-management stage because, for example, poorly conceived descriptors in the cataloguing step will

ultimately reduce the utility of materials to users. However, specialized dissemination operations are also required in order to inform potential users of the available information, and this includes the important function of creating user "access points". For example, some knowledge-management agencies have established branch terminals in libraries and elsewhere equipped with computers capable of searching information banks and returning requested materials to users within 24 hours (Havelock, et al., 1974:359). The NASA Office of Technology Utilization has regional centers and experienced marketing people who sell their information services to decision-makers (National Aeronautics and Space Administration, 1975). Dissemination also entails the creation of newsletters and brochures to inform users of new acquisitions, services and other news items. Finally, each step in the knowledge-management stage is evaluated (Step II-7) according to its contribution to satisfying user needs. This evaluation may occur through operation analyses, user-surveys, and other means of obtaining feedback on management performance.

To summarize, in the knowledge-management stage, user needs are discovered, the available literature is searched for materials relevant to these needs, and materials are packaged and disseminated to users. As indicated previously, the fields of education, defense, and medicine currently have knowledge-management services, and the National Technical Information Service (NTIS) of the Department of Commerce manages all federal R&D reports. Kiehl (1970) stated the case for a nationwide, integrated agricultural science information network run cooperatively by the USDA, National Agricultural Library and land-grant colleges. Besides the fact that this service would reduce the search time and

expand the quantity of research available to agricultural scientists, Kiehl points out that it would bring together the biological, physical, and social scientists responsible for agricultural knowledge-production.

> I feel that the reluctance of many scientists to move into more interdisciplinary research programs could be highly correlated with a grossly inadequate procedure in science information utilization. If the interfaces of disciplines were more freely exposed and utilized, the research enterprise would undoubtedly reflect a more favorable climate of tangible productivity (Kiehl, 1970:12).

Knowledge-Translation. Knowledge-translation involves synthesis and conversion of scientific research findings into information useful to product-developers in the formulation and solution of practical problems. Despite recognition of this important stage in knowledge-production-and-utilization (Guba, 1970; Short, 1973; Mackie, 1974; Rothman, 1974), translation--particularly in the field of social engineering--remains perhaps the least developed stage of the entire process. According to Havelock and associates (1974:66), "only one existing organization, the Congressional Research Service, has been set up to provide such a service on a routine basis". Considering the rapid growth of scientific research since World War II, translation skills, structures, and procedures are especially critical.

Similar to most other stages, translation begins with identification of user needs (Step III-1). Here translators specify their clientele and inform potential clients of the services they provide. Upon contact with a particular client or client-system, they discuss client needs and the uses to which translated knowledge will be put. For example, an 18-step translation procedure in a hypothetical "rapid response R&D service" started with an "information request statement" from clients and a "request

clarification and redefinition dialogue" between translator and client (Havelock, et al., 1974:68). Although initiative comes from the client,

> the core of this system is someone we call the 'writer-expert'. This person must be on the one hand, generally knowledgeable about the domain of R&D to which the request is directed and, on the other hand, able to write in a clear, integrated way for non-academic readers (1974:68).

Once the preliminary statement of the clients' problem is formulated, translators recode the problem (Step III-2) into terms which approximate relevant descriptors of research collected in the knowledge-management stage. As Rothman says, "practice perspectives ordinarily need to be translated into typical scientific linguistic analogues in order for scientific sources to be exploited" (1974:535). This step may be characterized as one of the specific "meeting-points" of abstract, scientific knowledge with the practical knowledge of clients. The meeting is arranged by a highly-skilled translator with a "dual understanding" of scientific and practical conceptions of the same problem.

As soon as the translator presents his/her information needs to the knowledge-manager, the manager searches the available literature with selected descriptors, packages research resulting from the search, and sends it to the translator for review (Step III-3). When sufficient research is collected and reviewed, translators draw it together in syntheses of information and propositions (Step III-4). The task of synthesis is one of:

> assembling details into a comprehensivle, analytically ordered and coherent system of ideas.... The separate pieces of information in the separate primary papers need to be joined to one another, fused with one another, welded into a coherent intellectual machine which may be used as a whole (Zieman in Short, 1973:254).

Syntheses of research findings for general use are of limited value, however, unless they are generalized (Step III-4) in propositions which are not so "distressingly specific to the task environment" as the findings themselves (Mackie, 1974:9). The generalizations from a body of research represent the initial emergence of guidelines useful in product-development, and these are results not of synthesis or generalization, but of both steps together. Rothman makes this point clear:

> When numerous studies in varying circumstances using different subjects and methodologies, are in substantial agreement, one can have a greater degree of confidence in the validity of these generalizations, particularly when there are few if any findings that yield counter conclusions (1974:537).

Following generalization, propositions are recoded (Step III-5) from the abstract language of science to the more concrete, practical categories of the developer. Recoded generalizations are then narrowed to "more finite specifications of location, contexts, and behaviors for implementation in the process of operationalization" (Rothman, 1974:538). Mackie describes this as "relating the operations, variables, and functional relationships found to be important in the laboratory to corresponding processes and variables in some operational environment" (Mackie, 1974: 7). Thus, operationalization (Step III-6) at this level involves the conversion of general propositions from scientific research to the information and guidelines required by developers in the formulation of client-problems and the design and construction of particular technologies for problem solution. One result of operationalization is "delimited scientific knowledge" which is sufficiently specific to users' problems to be directly useful in the problem-formulation step of product-development (Step IV-2). Delimited statements of relationships between variables drawn from scientific research may be used by the developer to specify the variables causing the user's problem. In the operationalization

step, the translator also produces technological knowledge or "decision rules...that lead to a predictable outcome under specified circumstances" (Nelson in Short, 1973:276). These decision rules or guidelines are drawn from generalized scientific propositions by the translator and applied to the particular variables causing the client's problem. They should enable the developer to manipulate and control the action of relevant variables; in doing so, they provide guidelines for the design and fabrication of technologies (Steps IV-3,4,5,6). The skilled translator, then reviews, synthesizes, generalizes, and operationalizes research literature in order to produce information pertaining to:

> certain specific problems and outcomes.... A particular technological product...is designed to control action insofar as pertinent technological knowledge will permit. The recommendations or guidelines within a given product are technically trustworthy to the extent that the rules are known (Short, 1973:260-261).

Translators derive these guidelines from scientific propositions and then package them for utilization by developers. As Havelock and associates indicate, packaging of translated research (Step III-7) for developers actually occurs throughout the translation stage in the form of extensive dialogue between translator and client (1974:66-69). This dialogue continues through the dissemination step in the translation stage (Step III-8) as translator and developer discuss conclusions.

The importance of evaluating the translation stage (Step III-9) is highlighted in Havelock's description of translation as:

> a continuing built-in cybernetic mechanism. The success and failure of each step in the sequence should be evaluated and the system should be reorganized accordingly. Most important is the feedback on the results of the total process in terms of user satisfaction and specific evidence of successful utilization (Havelock, et al., 1974:71).

In summary, then, outputs of the translation stage are reports, discussions, and presentations containing guidelines for product-development. These are drawn from the synthesis, generalization, and operationalization of scientific research usually drawn from the knowledge-management stage, and brought to bear the problem which the product aims to solve. The knowledge-translation stage is a crucial element in knowledge-production-and-utilization and require considerable development.

Product Development. Knowledge is transformed into useful products or technologies in the development stage. This, in many ways, is the heart of the entire knowledge-production-and-utilization process. Here, translated scientific and technological knowledge is combined with knowledge of ultimate user needs (real or created) to build solutions to user-problems. "Solutions" may be social or material technologies[8] and are developed in a broad three-phase framework: 1) identification and formulation of the problem; 2) invention of a solution; and 3) fabrication of a solution.

Developers should keep abreast of scientific and technological advances. However, they are primarily client-oriented and see their role mainly as solving client-problems and utilizing research knowledge to contribute to solution-building. Research

> knowledge is at best only one of a number of input factors in any practical situation. No practical problem can be solved using knowledge alone--a whole host of economic political, motivational, cultural, and other factors must be considered (Guba, 1968:39).

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[8]Coughenour refers to D.M. Friedman's definition of technology as "any set of standardized, replicable operations that regularly yield predetermined results" (1976:285).

Because product-development is user-oriented, it begins with the identification and formulation of client-problems.[9] Problem-identification (Step IV-2) is largely a matter of gathering data to monitor clients' behavior, needs, problems, and aspirations. It may be geared to a general class of consumers (e.g., product market surveys), to individual clients (e.g., counselling) or to any size of aggregate between these extremes.

Guba distinguishes three types of client-monitoring.[10] First, context assessment is

> a continual determination of the user's status on key variables with a view to identifying needs and problems... rather like a dynamic benchmark or baseline giving, as it were, a continuous motion picture film of what is going on (1968:57-58).

Second, consumer sampling seeks to reveal tastes and values of current and potential consumers. Current consumers are sampled in order "to confirm or validate earlier product design features, to find out, as it were, what the company did right" (Guba, 1971:33). The sample of potential consumers

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[9] It is recognized that certain developers, particularly the systems engineer, must maintain a "dual" research and client-orientation: "Systems engineering reviews the content of new knowledge, investigates the needs of customers and formulates the operational, performance, and economic objectives and broad technical plan in developing applications to meet customers' needs" (Hall, 1962:3). However, results are found not so much in the quantity of knowledge used as in the quantity and quality of the products used by consumers.

[10] It should be noted that the job of problem-identification through client-monitoring may be shared with product-disseminators (Step V-1). In general, disseminators (particularly market analysts in large organizations) will conduct surveys, process survey-data, and communicate these data (Step V-2) to developers in a form which facilitates developers' problem-identification and formulation. Elements of this cooperative relationship between developers and disseminators are discussed further in the dissemination stage.

"is needed in order to determine what changes might be necessary to attract new users. This is in effect an assessment of what the company might do right in the future" (Guba, 1971:33). Third, future studies assess consumer needs over a long period of time, say, 20 to 30 years. Boeing Aircraft used future studies to predict a decline in airline contracts and moved relatively painlessly into mass ground transit and community development (Guba, 1971:34).

On an individual or small-group level, Gouldner (1965) speaks of the clinical model of applied sociology which accounts for clients' hypotheses of problems at the same time that the consultant (whether extension agent, counsellor, or organizational development consultant) formulates his/her own hypotheses. Carl Rogers' (1951) method of non-directive counselling relies almost exclusively on client resources in the identification and resolution of problems.

Once user-needs are discovered, they must be organized in a form which enables designers to develop a solution. Gouldner suggests engaging in problem-formulation (Step IV-2) with individuals when he generates hypotheses to explain clients' behavior in the clinical model. In systems engineering, Hall describes the process of

> isolating, possibly quantifying, and relating that set of factors which will define the system and its environment. Since a problem is an outward expression of an unsatisfied need, the job is to find out what the need really is (1962:9).

Definition of this "real need" and its environment may proceed in at least two directions: through intensive investigation of the client-system and through review of scientific research bearing on the problem. The former course represents a specific point at which applied research is utilized in product-development while the latter course is one point at which translated scientific research is used to increase understanding of a problem. In

particular, developers require the following from the problem-formulation step: precise definition of the problem, specification of variables causing the problem, knowledge of the environment in which the problem occurs, and parameters of acceptable solutions. Chestnut calls these the "systems concepts" which make the problem intelligible (1967:27).

Invention (Step III-3) begins when a complete formulation of the problem is given to the designer.[11] The crucial importance of this step is highlighted in its breakdown into seven substeps; however, before detailing these, Guba's five-part typology of invention is presented to clarify the different ways in which invention may occur. An invention may be a: 1) transmission of a solution which already exists and only needs to be applied; 2) translation of a direct analog which only requires application; 3) transformation of an indirect analog which is converted into usable form; 4) synthesis of existing elements brought together in the appropriate form to yield a new solution; and 5) creation of a new solution (Guba, 1968:45).[12] Black (1974:20), Langrish (1974), and Marquis and Allen (1969) all indicate that many new products are not so much "new" products

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[11] Invention refers to the process by which new products are conceived and designed for fabrication. In this sense, some inventions may be original creations while others may simply be re-designs of existing products.

[12] Note the similarities of this conceptualization with the following typology of "sources of appropriate technologies" in less-developed countries: 1) existing, indigenous technologies; 2) improved existing technologies; 3) an unchanged, imported technology; 4) an adapted, imported technology; and 5) a newly-invented technology (German Foundation for Developing Countries, 1972:9). For an extensive discussion of appropriate technology, see OECD Development Centre, 1975.

as they are transmissions, translations, transformations, or syntheses of existing ones. For example, Black quotes one industrial executive as saying:

> Company 'X' developed a very similar line independently and we began copying each other. We break open their black boxes to see what they have and they do ours, but we redesign it. All that does is save us time--we don't have to reinvent each one from scratch. We get some idea of how they did it, and then we go do it ourselves (Black, 1974:20).

The seven-step approach to invention described here is deductive and is drawn largely from systems engineering. Gosling vividly describes the systems approach when he writes:

> The search for a system solution which meets the given specification proceeds by partitioning the universe of all possible systems. If an enclosure can be established within which the required system is known to lie, and if the number of systems contained within the enclosure can be progressively reduced, then a convergent process has been established which will ultimately lead to the required system design (1962:52).

Before the solution is designed, two types of specifications are required, (Step IV-3a, Fig. 4). First, performance specifications are needed because they "guide the search for solution alternatives, imply the types of analyses required of the alternatives, and provide the criteria for selecting the optimum system" (Hall, 1962:9). In other words, with the client's problem sufficiently formulated, goals and measures of success for resolving the problem can be stated as behavioral, technical, or monetary objectives. These objectives then guide the design and fabrication of the solution. Second, several writers point to the need for what are called appeal specifications. For example, Spooner-Smith and others (1974:3) say that developers must establish not only performance objectives for solutions

but specify the means by which solutions will be used. Thus, they delineated appeal specifications for an educational innovation which accounted for users' time schedule, action-decision orientation, technical ease, and socio-political concerns. Similarly, Popham and Baker in education seek to account for "those entry behaviors that are prerequisites if learners are to profit most efficiently from the product" (1971:132).

In the field of international technology transfer and agricultural extension, careful drafting of performance and appeal specifications appears to be especially crucial.[13] This need arises, in part, because introduction of scientific technologies in ethnoscientific cultures often represents a significant departure from traditional farming practices.[14] As a result, certain pre-conditions (e.g., education, literacy, and tenure rights) must be met if new technologies are to be effectively utilized because these pre-conditions significantly affect "entry behaviors" for adopting innovations. These behaviors should be specified at the outset of product-development if designers' and agents' performance criteria are to approximate those of the client. This is one example of the need for utilizating clients' knowledge in systematic conjunction with scientific research knowledge. Thus, Schutjer and Van Der Need find it "not surprising

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[13] Problem-identification and formulation are, of course, crucial as well; in fact, sound specifications depend upon sound problem-formulation.

[14] Ethnoscience refers to the concepts, propositions and theories which a culture group uses to understand the world. For a discussion of the utilization of a group's ethnoscientific knowledge in agricultural development, see Knight, 1974.

that a recent review of rural development programs in Africa concluded that successful programs require local participation in the design and operation of the program activities" (Lele, 1975; 1976:40). Similarly, Wharton (1969) points to agents' and clients' differential perception of risk in adopting new technologies; these may be reconciled if, once again, farmers are drawn into technology-development at the point of establishing performance and appeal specifications. The 1976 World Food Conference recognized the need for expanded success criteria when it concluded that

> In future decisions regarding selection and diffusion of technology, emphasis should be given to specifying conditions that will have to prevail for the specified technologies to be accepted and integrated into farming and family and community patterns of living (1976:679- emphasis added).

These conclusions clearly indicate that specifications should go beyond narrow measures of technical performance to consideration of pre-conditions and "entry behaviors" for effective utilization of new technologies. In this monograph, the addition of "appeal" to the usual "performance" specifications aims to help resolve this problem.

Performance and appeal specifications provide the parameters necessary for designers to begin their work. Their first job is to determine the product's general function (Step IV-3B) or the "largest solution space within which to design the system" (Nadler, 1967:B-647). Here the widest social and physical parameters within which the product must operate are delineated and the general way in which it will solve the user's problem is stated. This space is then gradually "filled" by alternative functional models (Step IV-3c) of solution-systems created by designers. In industry, for example, "functional flow drawings are prepared to show in detail the function that

must be accomplished to meet the criteria and design requirements" (Chestnut, 1967:28). Further, "functional requirements for power, signals, cooling, heat, light, sensing actuation, or other specific conditions should be entered where they are significant" (Chestnut, 1967:28-emphasis added). Similar to performance and appeal specifications, then, functional models should go beyond development of the product itself to delineation of the socio-physical environment required for effective utilization of the product. These models should conform to the highest performance standards of designers drafted earlier.

Following the design of functional models, each is analyzed and assessed (Step IV-3d). Analysis entails rigorous study of each solution according to performance, cost, quality, and other relevant criteria (Hall, 1952:9 and Nadler, 1967:B-648). It aims to determine the technical soundness and marketability of each solution. Assessment takes its cue from emerging social/environmental concerns and the field of technology assessment as it deduces the intended and unintended consequences of new technologies.[15] In some cases--such as automobile exhaust-control standards--new Federal regulations make this necessary, but increasingly sophisticated predictive methods and pressing social priorities make assessment feasible and probably desirable for private as well as public product-developers.[16] It is important to note that analysis/assessment may reveal the need for

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[15] J.E. Mock defines technology assessment as: "the systematic study of the effects on society that may occur when a technology is introduced, extended, or modified, with special emphasis on impacts which were unintended or delayed" (in Coates and Mock, 1974:6).

[16] Bereano (1976) reviews and critiques a number of these techniques including trend extrapolation, Delphi technique, game models, and contingency trees.

further research on a product or on the problem which the product aims to solve. Thus, designers may enlist the services of knowledge-translators, managers, applied scientists or basic scientists to help answer questions they themselves cannot answer.

The obvious next step is to select the optimal solution from the alternatives (Step IV-3e) by "evaluating the analyses and assessments and comparing these...with the objectives to select the smallest possible subset of alternative systems which merit further study" (Hall, 1962:9). Further revisions are then made until the designer is able to "move from conceptual to working models" (Chase, 1969) in the creation of a prototype solution (Step IV-3f). Here, "exact details of the solution are prescribed... and all the design parameters are specified in their multi-dimensional form" (Nadler, 1967:B-648). The functional model is "realized" in a structural model which simulates as closely as possible the final product, and this, according to Gosling (1962:91), is the most difficult part ot the entire invention process. The structural model then undergoes pre-fabrication review (Step IV-3g) by the designer and others concerned with the product. In fact, Chestnut from systems engineering, says that "final review should be the culmination of periodic design reviews with the customers. These should take place at regular intervals which may coincide with significant stages of time or engineering accomplishment" (1967:30). Although customer review may not be feasible for all types of products, it would appear to be applicable to involvement of ultimate users in Third World small-farmer extension programs. In this regard, Kilby says: "engineers must be willing to work in the fields with the farmers--to demonstrate and test their own prototypes and not leave this to their assistants" (in East-West Center,

1973:6). Further, they "must be allowed to work on a single project, such as a power tiller, for at least five years, the mean time it takes to adapt an exotic design and bring it to the stage where it can be locally-produced" (in East-West Center, 1973:6).

The critical invention step is completed when the review team (composed of developers and perhaps clients, disseminators, and others) approves the protoype design and sends it to the production engineer for fabrication. The engineer first builds a prototype product from the design (Step IV-4); tests the product under laboratory conditions (Step IV-5); and finally tests and re-tests the revised product under conditions of actual use (Step IV-5 continued). The aim here is to work out the inevitable "bugs" in the solution as it makes its way from the mind of the designer into the hands of the consumer. Testing in a variety of settings enables the developer to gauge performance more precisely and reveals "modifications required by characteristics of the population served and other variations in situations" (Chase, 1968:9).

Following final testing is the step of fabrication of a marketable solution (Step IV-6). This solution should have withstood many tests of durability, economy, performance, and appeal beginning early in the invention step, and is now deemed "market ready." Before entering the dissemination stage, however, the product needs to be "packaged" in a form which facilitates adoption (Step IV-7). If packaging criteria were used from the time that "appeal specifications" were first stated, packaging at this point should be relatively easy. It may include preparation of instruction-manuals for consumers and training sessions for disseminators as well as product "cosmetics" for consumer appeal.

The development stage concludes with the transfer of the marketable product to disseminators (Step IV-8) and evaluation of development operations (Step IV-9). The goal and importance of evaluation is stated succinctly by Popham and Baker (1967:134):

> The staff appraises the adequacy of the procedures which were employed in preparing the product. Rules which guided the developmental process are scrutinized and rule modifications are often suggested. Alternate ways of approaching problems will be considered. The results of this step are usually added to an evolving set of guidelines concerning the product development cycle.

Product-Dissemination. Two approaches to product-dissemination can be delineated in the literature and we combine these in a single synthetic approach to dissemination. The first approach is "development-oriented" and "calls for most of the effort to be spent on discovering the wants of a target-audience and then creating the goods and services to satisfy them" (Kotler and Zaltman, 1971:5). The second is "promotion-oriented" and aims principally to create "awareness about new developments and the provision of opportunities for their assessment along whatever dimensions practitioners deem necessary" (Guba, 1968:42). Whereas the first approach emphasizes a cooperative relationship between developers and disseminators in the joint creation of products to satisfy users, the second assumes appropriate products and emphasizes strategies for their diffusion. In the synthetic approach presented here, an attempt is made to merge elements of both approaches.

Developer-disseminator cooperation is revealed in the first four steps of dissemination. First, similar to developers, disseminators identify user needs (Step V-1) through market studies, consumer samples, personal interviews, and other means. Methods of discovering user-needs depend upon the

nature and size of the audience. The need for careful selection of the proper methods is highlighted by Dodge in the field of industry: "Insufficient or faulty market study appears to be the principal cause for disappointment with new products. Management does not seem capable of gauging accurately the nature or the size of the market" (1970:152).[17] Similarly, on the individual level, the counsellor or social worker needs to "gauge accurately" the nature of their client's problems. Results of the user-analysis are then communicated to product-developers (Step V-2) in a form which enables them to formulate the user's problem and eventually create a solution to it. For example, in industry, statistical results of market studies should be interpreted and communicated in such a way that inferences affecting product-development are clearly drawn out and easily understood. In agricultural extension, Roling, et al. (1976:164) speak of the need for research on the adoption of agricultural technology to yield "'feedforward' to future agricultural research on innovations and to its potential in developing replicable, prototype strategies for more equitable development."[18]

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[17] Dodge (1970:124-136) describes several other methods of determining mass consumer needs under the headings of sales research and market research. As stated earlier, disseminators particularly market analysts, usually conduct and interpret user surveys while developers use these interpretations of data to make decisions on product-design and fabrication. Although, their ultimate contributions to knowledge-utilization differ (that is, developers develop products while disseminators disseminate them), the performance of each depends upon their understanding of client needs and both will be more effective if they cooperate rather than work apart from one another.

[18] Everett Rogers defines feedforward "as information about the receivers that is gained by the source prior to initiating communication, and is used to predict the effectiveness of communication" (in Roling, et al., 1976:168).

Beyond communication of user-needs, disseminators should assist developers in problem-formulation, product-invention, and product-testing (Step V-3). In each case, disseminators will probably contribute more to refining appeal rather than performance characteristics of products as in the crucial jobs of drafting product specifications, analysis and assessment, and final design review in the oeverall invention step (in Step IV-3). Additionally, disseminators can assist developers in the field-testing of products (Step IV-6).

When a product is finally market-ready, disseminators should interact with developers in order to understand the product sufficiently to convey and demonstrate its value to potential users (Step V-2). This understanding should include knowledge of the performance and appeal characteristics built into the product and any instructional materials. Upon completion of this step, the development-orientation gives way to the promotions-orientation.

The first promotional step is the planning and design of a dissemination and distribution strategy (Step V-5), and although it is presented at this point in the dissemination stage, it generally occurs concurrently with a number of previous steps. For example, during product-development, Dodge says that "advertising develops tentative campaigns for the introductory period of distribution and the subsequent six or twelve months" (Dodge, 1970:169). Kotler and Zaltman (1971) discuss the major problems of dissemination strategy in terms of controlling four key variables--product, price, place, and promotion. First, the product variable is manipulated primarily in the product-development and early dissemination stages as "sellers study the needs and wants of target buyers and attempt to design products and services that meet these demands. If well designed and affordable, these products will be purchased" (Kotler and Zaltman, 1971:7). Second,

price "represents the costs that the buyer must accept in order to obtain the product and...includes money costs, opportunity costs, energy costs and psychic costs" (1971:9). This generalized concept of pricing assumes that consumers weigh these diverse costs against equally-diverse benefits in deciding for or against product-adoption. Third, the place variable "calls for providing adequate and compatible distribution and response channels" (1971:8). Primary considerations in determining the number, location, and nature of distribution outlets are the energy and psychic costs to consumers; and optimal placement of outlets reduces these costs to a minimum. Fourth, the promotion variable is concerned with product-dissemination in its strictest sense, and is discussed separately in the following paragraph as step six in the dissemination stage.

Communication of product-messages (Step V-6) marks the implementation of the dissemination strategy and may be classified according to the size and type of audience to which messages are addressed. First, in mass dissemination, advertising, publicity, and sales promotion are the primary forms of communication with clients.[19] Advertising is any paid form of non-personal promotion of products by an identified sponsor while publicity consists of unpaid information and promotions where the sponsor is unidentified. Sales-promotion, then, consists of miscellaneous paid messages (e.g., incentives, special offers) aimed to stimulate audience interest in a product (Kotler and Zaltman, 1971:7). Informing is similar to advertising, publicity, and sales promotion except that it emphasizes awareness-creation rather than hard-selling of products (Guba, 1968).

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[19]Kotler and Zaltman (1971) point out that mass marketing techniques may be as successful in the dissemination of social technologies, programs, and services as they are in seeling commercial products.

Secondly, at the individual or group level, messages may be communicated through personal selling, demonstration, consulting, counselling or informing. First of all, personal selling is any paid, person-to-person promotion of a product by an identified sponsor (Kotler and Zaltman, 1971:7). The door-to-door salesperson of Fuller Brush products or Avon cosmetics are well-known representatives of the personal sales approach. Secondly, demonstration creates situations which enable users to "examine the feasibility of innovations, to understand factors affecting their use, and to consider their adaptation to other settings" (Archer and Korstetter, 1967:121). In agricultural extension, the "demonstration plot" enables farmers to observe the growth of new plant varieties and has become a mainstay of dissemination programs in agriculture.

Third, consulting (in organizational development, for example) involves a temporary relationship with a client in which problems are analyzed and solutions are reached over a period of time. Solutions to problems are generally presented in any of a variety of "temporary systems" (Miles, 1967). Collaborative action inquiry, human relations laboratories and survey feedback are all examples of temporary systems used by consultants to communicate solutions to clients (Havelock, 1971:4-6).[20] Fourth,

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[20] A number of organizational development consultancy models are available. Kolb and Frohman (1970), for example, present a seven-stage, developmental model of the consultancy process: scouting, entry, diagnosis, planning (with feedback to entry), action, evaluation (with feedback to planning), and termination. In a study of 40 Netherlands industrial organizations, Van de Vall, et al. (1976) present 15 conclusions on the functions, structure, theory and methods of applied social research in organizational development consultancy. Among these is the conclusion that internal social researchers are superior to consultants as agents of planned social intervention.

Lippitt (1976) describes three patterns of knowledge-utilization in which external scientific knowledge is brought into a consumer system and three patterns in which scientific knowledge is built up within the system and then utilized by practitioners. Counselling is similar to consulting except that it is usually restricted to individuals and very small groups and aims to solve personal, social-psychological problems of clients. Lastly, informing may be done on the individual or group level by consultants, counsellors and teacher/trainers to encourage clients to create solutions to their own problems.

Concurrent with or prior to the communication of product-messages, distribution channels are opened in order to allow users easy access to products (Step V-7). The key to product-distribution is the design and placement of outlets in such a way that those people motivated by promotional messages are enabled to view, perhaps try-test, and adopt and purchase the product in a manner most agreeable to them. Outlets are staffed by people who are trained to do their jobs. In addition to the usual technical and sales personnel engaged in distribution services, a trend in recent years has been toward involvement of para-professionals (e.g., counsellors, and nurses) and volunteers to widen the base of scarce services.

In some cases, consumers will be able to assimilate a product with a minimal amount of adaptation. In other cases, disseminators will need to assist consumers in adapting the solution to particular personal and environmental conditions and installing it therein (Step V-8). In education, Guba says: "No invention will fit exactly into a local school situation for which it was not explicitly designed. Decisions will have to be made whether the fit can best be accomplished by modifications in the

invention itself or in the school situation" (1968:50). Acute problems of adaptation in Third World extension programming have led to the coining of a term, "adaptive technology." Here, the requirement of adaptation to user conditions is so important that perhaps it should form the basis of the entire agricultural knowledge-production-and-utilization system.[21]

A continuing step in product-dissemination is that of monitoring product-performance (Step V-9). Here the disseminator uses "research, evaluation and feedback from users and observers to modify, complement, and/or replace systems as new needs appear or as higher levels of performance are required" (Chase, 1968). Modification may simply involve "fine-tuning" or servicing the product or repair of a malfunctioning product. Monitoring may reveal that the product should be replaced with an improved one or that a new version of the same product can simply be resold to the consumer.

Similar to other stages, product-dissemination concludes by evaluating all dissemination operations (Step V-10).

Product Adoption/Utilization. In the final stage of knowledge-production-and-utilization, attention shifts from the process by which knowledge--in the form of social or material technologies--is prepared for adoption and utilization to the process by which it is actually adopted and utilized. We distinguish between adoption and utilization because effective utilization of technologies is the ultimate goal of knowledge-production-and-utilization; yet much research focusses on the diffusion of innovations only up to the

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[21] See Schumacher, 1973; Organization for Economic Cooperation for Development, 1975; Ensminger, 1976; and Schutjer and Van Der Neen, 1976.

point of adoption. The importance of this distinction in highlighted in one of the two major conclusions of Schutjer and Van Der Neen's review of agricultural technology-utilization literature in less-developed countries:

> Technology-based agricultural and rural development programs and policies have tended to focus on adoption as contrasted with effective utilization.... Relative emphasis on technology adoption rather than utilization has detracted from the fact that the agricultural technology made available to farmers is often complex in application and requires a package of related inputs and practices to assure effective utilization (1976:42).

Adoption is defined as "the decision to make full use of a new idea as the best course of action available" (Rogers, 1971:20). Although "full use" implies utilization beyond mere adoption, it does not fulfill the criteria of continuity and valuation established by Chase (19t7:126).[22] Utilization then, occurs when adopters "assimilate the invention as an integral and accepted component of the system...and establish it as part of an ongoing program" (Chase, 1957:126). Similarly, Guba says: "at some point, the innovation must cease to be viewed as new and must become an integral and accepted component" (1968:50). Only then will maximum benefits be derived from the knowledge-production-and-utilization process.

The adoption/utilization process begins with users living with their current needs, behaviors, technologies, and wants (Step VI-1). Delineation of this as a separate step is important because it recognizes the "baseline" from which new needs or problems arise. Rogers calls these "antecedents" or "those variables present in the situation prior to the introduction of an innovation" (1971:103). Key variables include users' personality characteristics, social characteristics, and the physical and social environment in which the user lives.

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[22] Chase's criteria for effective utilization or institutionalization are: continuity of use, strength of clients' valuation; and capability of clients to support or maintain it (1967:126).

User needs change constantly and failure to fulfill a certain need leads the user to discover it as a problem (Step VI-2). Problems may be discovered in three ways. First, users may discover them as felt needs. Second, they may be suggested by an external source such as a salesman. Third, problems may be discovered in the course of a joint analysis of needs by an agent and client.

Problem-diagnosis (Step VI-3), follows problem-discovery. This step is similar to the researcher's "problem-conceptualization" and the developer's "problem-formulation" steps. Here the user engages in introspection, study, discussion or experiential learning to isolate and interrelate the variables causing the problem. Diagnosis may be done with or without a resource person, but a skilled resource person will often increase the precision with which diagnoses are carried out.

If the user decides that external help or an external solution to the problem is required, he/she will engage in a search for a solution (Step VI-4). The search will be guided largely by a user's "antecedents" and the limits of available resources, but will also involve a cost/benefit analysis (in the general sense of Kotler and Zaltman, 1971) and evaluation of possible solutions.[23]

The user may then evince interest in one or several particular solutions (Step VI-5) and seek greater information and spend more time examining these alternatives. Continued interest in a particular solution may lead

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[23] In the area of social science research-utilization in policy-making, Goslin states the need for policy makers to learn how to search for solutions in research: "policy-makers must learn to ask the right questions in the right way, and to recognize that the social scientist faces difficulties in providing answers that are helpful, but do not misrepresent either the current state of knowledge or the complexity of the problem" (1974:512).

to its try-testing by the user to build greater familiarity with it and assess its quality, value, fit, and utility in the user's situation (Stufflebeam, 1967:126). Guba recognizes this in education when he says: "a local trial is mandatory even when national assessments have indicated that the solution performs well on the average, for the obvious reason that the situation in which installation is proposed may not be average" (1968:49-50). Further, in agricultural extension,

> the literature is clear on the need to adjust specific practices to local conditions. Generally speaking, fertilizer and pesticide recommendations are for general, agronomic practices such as spacing and depth of planting and need to reflect more accurately variation in soil type, rainfall patterns, and related factors (Schutjer and Van Der Neen, 1976:43).

Try-testing is an important step in achieving adaptation to the particular personal, social and environmental characteristics of users.

Try-testing generally supplies consumers with sufficient information to decide whether or not to adopt the solution (Step VI-7). "Most individuals who try an innovation then move on to an adoption decision, if the innovation has at least a certain degree of relative advantage" (Rogers, 1971:113). Following adoption, the solution is adapted to and installed (Step VI-8) in the user's existing system. This step generally occurs in conjunction with the adaptation/installation step of dissemination as the characteristics of the solution are fitted to the specific characteristics of the adopter's situation. To repeat Guba's statement, "decisions will have to be made about whether the fit can best be accomplished by modifications in the invention itself or in the...situation" (1968:50). Installation may entail training the user in the operation of the solution through specialized instruction or operator manuals. If an innovation is effectively utilized or assimilated in the user-system over a reasonable period of time, it is institutionalized in the user-system (Step VI-9). Chances of institutionalizing

certain products are often improved by disseminators' willingness and ability to service and repair them. Reinforcement from peers can further enhance institutionalization (Rogers, 1971:113). Although successful achievement of this step is often considered the ultimate goal of knowledge-production-and-utilization, institutionalization is desirable only for the time-period in which no superior solutions to the client's problem are available. It can result in a dysfunctional adherence to particular solutions which were once new and innovative but subsequently became obsolescent.

The final step of the product adoption/utilization stage is the user's ongoing evaluation of the solution (Step VI-10). Evaluation may result in continued use, repair, adaptation, discontinuance or replacement of the technology.

Conclusions

Completion of the product-adoption/utilization stage marks the end of a knowledge-production-and-utilization process which, at its best, results in the solution of user problems to their maximum satisfaction. Before the model is "activated" in its dynamic form, two final points should be made. First, the static model aimed to achieve completeness, specificity, and pedagogical clarity by breaking down the knowledge-production-and-utilization process into six broad stages and then breaking down these stages into component steps. The stages represented different sets of activities with different outputs and indicated the specializations required for successful completion of the process.

Second, these specialized activities represent knowledge-production-and-utilization structures which must be permeated by continual communication if

each stage is to contribute fully to the task of making knowledge useful. Recognition of the importance of "transition requirements" in each stage to effect this communication is embodied in our suggestion that each of the middle stages is a knowledge-production-and-utilization unit in itself. That is, in each stage, actors begin by identifying specified user needs, planning outputs according to these needs and packaging outputs to appeal to its clientele. Although the ultimate user in the product-adoption/utilization stage is the ultimate target, actors in each stage must meet the needs of users in other stages if the needs of the ultimate user are to be met.

The static model will have served its purpose if it helps the scholar and practitioner to understand the complex tasks involved in each stage and the relations among stages. Such understanding can help participants in each stage understand the activities and needs of participants in other stages, and thereby to strengthen the basis upon which communication occurs on the utilization chain.

B. Two, Iterative Dynamic Flows of Knowledge-Production-and-Utilization

The static model tends to be interpreted as an orderly, relatively linear flow from knowledge-production through the middle stages to adoption/utilization. However, we have continually attempted to emphasize: 1) that initiative for action may originate at any stage; 2) the importance of interaction feedback among and within stages; and 3) the increasing attention being given to user needs and involvements in the utilization process. The two dynamic models presented here emphasize an iterative process which it is believed portrays more closely the use and conversion of knowledge under real-world conditions. Steps are skipped, merged one into another, and rearranged until ultimately the previously-linear flow becomes an interactive movement involving several stages. Hopefully the static model enables one to establish a framework for understanding the highly complex interaction characteristic of real-world knowledge-production-and-utilization.

Two illustrative "paths" of knowledge-production-and-utilization under dynamic conditions are presented--one from agriculture (Figure 5) and the other from industry (Figure 6). A wide variety of other paths are possible--from such diverse fields of knowledge-utilization as organizational development consultancy, education, counselling, technology transfer, and social work. The first example from agriculture presents a "walk-through" of every step in every stage of the model so that the entire range of activities are interrelated and laid before the reader.[24] The second example from industry is a more abbreviated walk-through showing a very different path.

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[24]The idea of "walk-through" models is from Gideonse (1968).

1. Knowledge-production-and-utilization in agriculture. In Figure 5, each number corresponds to a step or sub-step in each stage of the static model. The source of initiative for this particular path of utilization is the farmer in Stage VI who lives with his/her current needs (Step VI-1) for fertilizers, pesticides, and so on and then discovers a problem (Step VI-2). The problem is that current pesticides do not control a certain insect; as a result the corn-yield has been reduced significantly. The farmer and a technical field representative of a pesticide firm discuss the problem and they identify the farmer's need (Step V-1). Farmer and representative then jointly diagnose the problem (Step VI-2). The field representative (perhaps with an extension agent) communicates this need to a product-developer (Step V-2) in a pesticide firm who thereby identifies the problem (Step IV-1) and sets out to formulate the problem by means of a research review of corn pesticides and further investigation of the social and physical environmental problems of the farmer (Step IV-2a and b). In doing so, the developer contacts a knowledge-translator to generate a synthesized, generalized, and operationalized packet of knowledge on the corn pest problem (Steps III-1-8). Much of this knowledge is received from knowledge-management services through designation of appropriate descriptors (Steps II-1-6). However, certain questions remain unanswered and the developer calls upon applied social and physical scientists to conduct experiments which clarify the operation of variables causing the farmer's problem (Steps I 9AR)-1-9). In their literature reviews (Step I (AR)-3), the applied researchers utilize basic scientific knowledge retrieved, catalogued, and stored by a nationwide agricultural information-management service similar to that described by Kiehl (1970) (Steps II-1-6). This knowledge was gathered over time from basic research projects in chemistry, economics, sociology, entymology, and other sciences (Steps I (BR)-1-8). The applied researcher reviews this

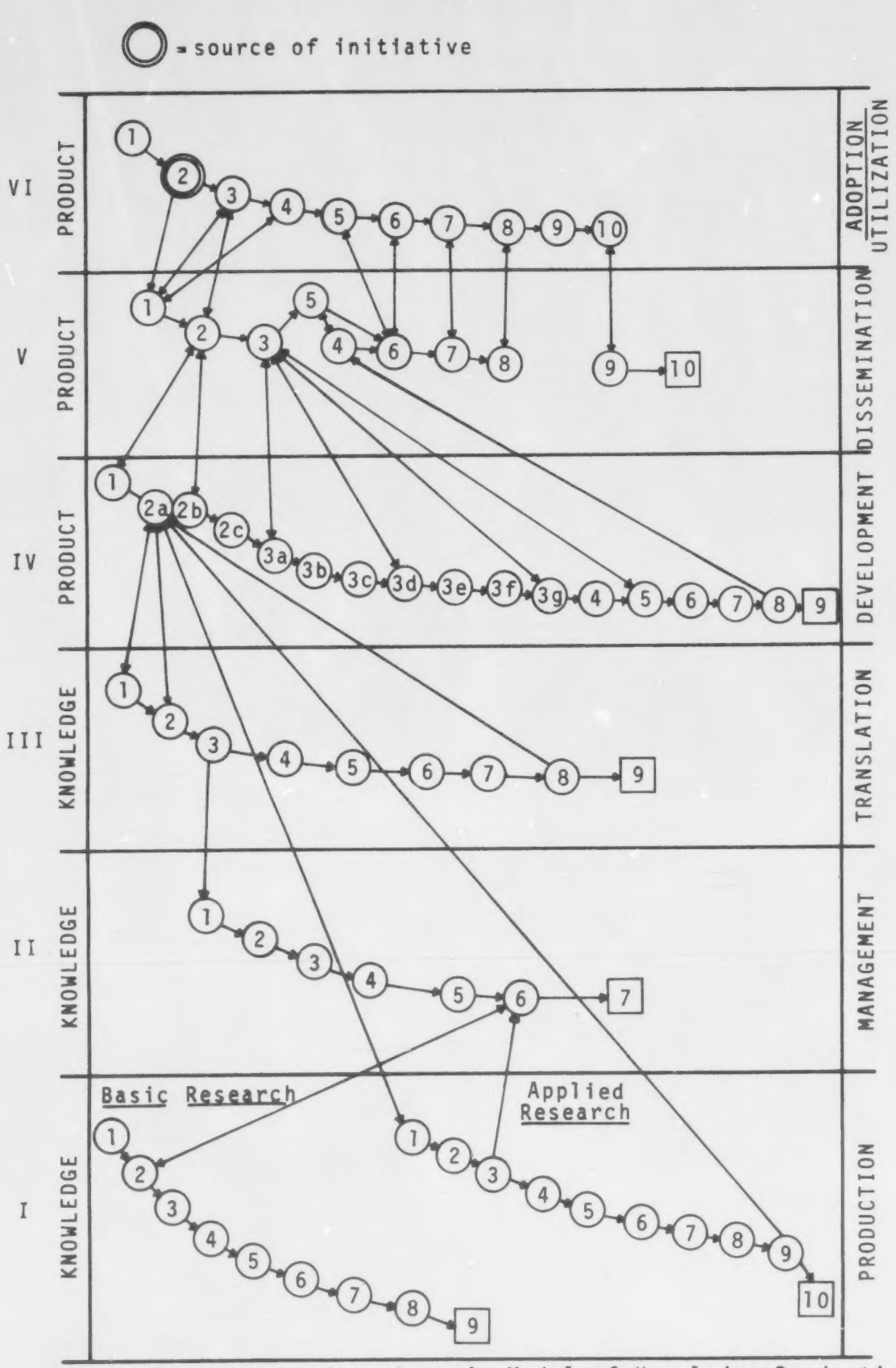

Figure 5. An Iterative, Dynamic Model of Knowledge-Production-and-Utilization in Agriculture

research, conducts experiments in the laboratory and the field, and then packages, translates and communicates the results (Steps I-8&9) to the product-developer to assist in problem-formulation. With sufficient empirical and theoretical knowledge of relevant variables, the developer begins the extended process of invention (Step IV-3a-g). At this point (with sufficient knowledge produced and communicated to the developer), interaction on the knowledge-production-and-utilization chain shifts decidedly to product-development, dissemination, and adoption/utilization (Stages IV-VII).

During invention, extension agents and field representatives assist wherever necessary in the drafting of performance and appeal specifications (Step IV-3a), analysis and assessment (Step IV-3d), and final review (Step IV-3g). Disseminators as well as a sample of potential users further assist in field-testing (Step IV-5). At the same time, agents and marketing specialists begin to plan alternative dissemination and distribution strategies according to place, price, product, and promotion variables (Step V-5). When the product is finally deemed market-ready, it is fabricated (Step IV-6), packaged with instructions and an appealing appearance (Step IV-7), and transferred to disseminators (Step IV-8). Agents and salesmen study and learn about the use of the product until they understand the product (Step V-4); and, if necessary, they revise and implement the previously-designed dissemination/distribution strategy. Implementation occurs when product-messages are communicated to farmers through advertising, promotions, demonstrations, consultation, and selling (Step V-6). This is likely to involve a variety of personal and impersonal contacts with farmers over an extended period of time. Disseminators may encourage try-tests or even include free try-tests of the product in their dissemination/demonstration package (Step VI-6).

Farmers begin to purchase the new pesticide through conveniently-located sales points in the distribution channels (Step V-7). Agents and salesmen assist farmers in the final adaptation and installation of the pesticide in their particular farming systems (Step V-8 and VI-8). Based on continued need and satisfactory product-performance, the new pesticide is repurchased and finally institutionalized by farmers over time (Step VI-9). Farmers evaluate the product while agents and salesmen monitor its performance and action is taken by disseminators and users over the years to improve and perhaps eventually replace the pesticide with a better one (Step V-9 and VI-10).

An entire cycle of knowledge-production-and-utilization has been completed to illustrate the possible interaction of steps and stages on the utilization chain. In this case, initiative came from the client; was channelled through dissemination, development, translation, management, and production stages; and then came back to the client in the form of a solution to the original problem--a corn pesticide.

In the following model from industry, a different, abbreviated path is pursued.

2. Knowledge-production-and-utilization in industry. This example of knowledge-production-and-utilization is drawn from what appears to be a common source-of-initiative in industry - the product-developer, perhaps in cooperation with the market analyst. As mentioned earlier, one executive has said:

> Company 'X' developed a very similar line independently and we began copying each other. We break open their black boxes to see what they have and they do ours, but we redesign it. All that does is save us time--we don't have to re-invent each one from scratch. We get some idea of how they did it; and then we go do it ourselves (Black, 1974:20).

The implication here is that little or no new basic or applied research is used; instead, emphasis is placed on design of an improved product rather than creation of a new one. In Guba's typology of invention, this would be translation or synthesis of "existing elements" (Guba, 1968:45).

Figure 6 portrays a utilization path which starts with product-development as the source of initiative. Here, the clients' problem is already known and there is a demonstrated market for the product; further, the scientific basis of the product is assumed and is of no major concern to the developer. Thus, the process begins with product-invention (Step IV-3) as developers analyze and assess the existing, competitor's product and then design alternatives to the product (Steps IV-3c and d). The optimal design is selected and a prototype is then designed and reviewed with the assistance of disseminators (Steps IV-e,f,g, and Step V-3). At the same time, disseminators design alternative promotional strategies (Step V-5). A prototype product is fabricated, tested and re-tested in lab and field conditions, and finally a marketable solution is fabricated (Steps IV-4,5,6). The finished product is then packaged and transferred to disseminators for their analysis and understanding (Steps IV-7,8, and Step V-4). Product-messages are communicated through advertising, promotions, demonstrations, and personal setting and made available to consumers through distribution outlets (Step IV-6,7). Interested consumers adopt (buy), adapt, and install the product to suit their particular needs (Step V-7,8). Over time, it is institutionalized and perhaps serviced, repaired, replaced, or resold (Step VI-9,10 and Step V-9).

This brief walk-through of knowledge-production-and-utilization in what appears to be a common industrial situation contrasts sharply with the model

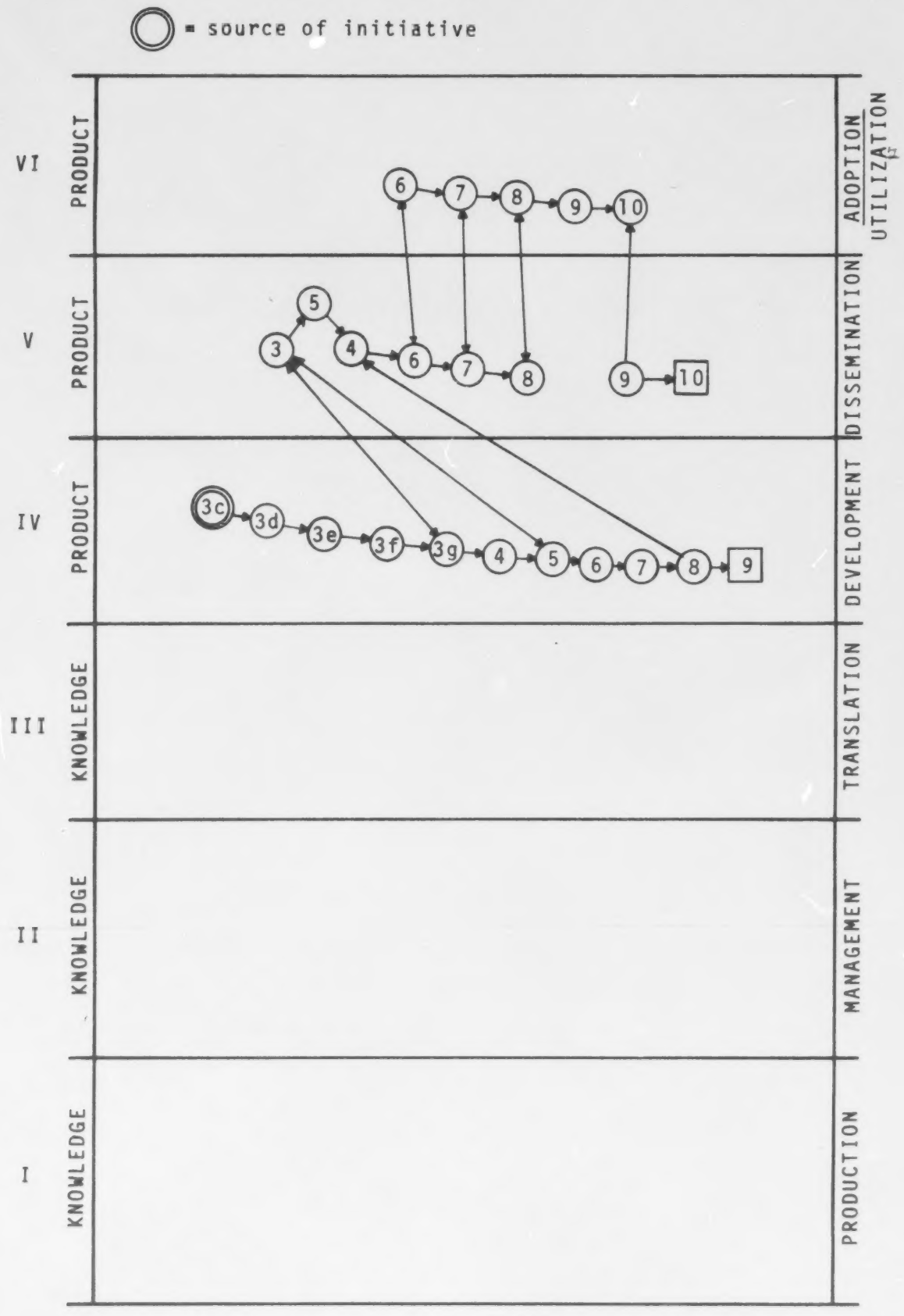

Figure 6. An Iterative, Dynamic Model of Knowledge-Production-and Utilization in Industry

applied to agriculture; and this serves to indicate the variety of ways in which the process may occur. In some cases, the patterns portrayed here may be reversed - agriculture may minimize scientific knowledge-utilization while industry may draw upon it heavily for certain products.

These examples are only two of many possible approaches to knowledge-production-and-utilization within the dynamic framework presented here. In both cases, the results--user-satisfaction--are the same, but the processes from which this satisfaction results are different.

IV.

SUMMARY AND CONCLUSION

In concluding this report, we review the central themes of the presentation, summarize problem-areas and conceptual gaps, and suggest area of needed future research and development.

At the outset, we noted the importance of knowledge-production-and-utilization as a process basic to the operation of a modern, industrial society. We further noted the increasing recognition of the need for additional development and more effective utilization of the process to help in the solution of problems of the disadvantaged in developing countries. The limited amount of research and understanding of the process in its entirety was pointed out. A working definition of knowledge-production-and-utilization was presented. While recognizing the importance of knowledge produced from scientific research, the definition differed from others in its explicit recognition of utilizing the knowledge of all system-participants - particularly ultimate users - in the development of solutions to user-problems.

An historical sketch of knowledge-production-and-utilization theory was presented. A review of three mutually-reinforcing theoretical approaches - the linkage, configurational, and iterative, output-oriented perspectives - provided some background on the assumptions and orientations which helped shape the authors' general model of knowledge-production-and-utilization.

The general model was presented in two forms - static and iterative, dynamic - in an attempt to explain the complete process in as much detail and with as much realism as possible. The aim of completeness was indicated in the broadening of knowledge-production-and-utilization to six stages and

the detail was realized in specification of at least seven steps in each stage. Realism was sought in the illustrative walk-throughs of the basic model using an agriculture and industrial example.

A primary aim in presenting this report was a preliminary codification of our understanding of knowledge-production-and-utilization so that strong and weak points in our conceptualization could be delineated.

Surveying the process as a whole, each stage makes important contributions to the solution of user-needs. Special attention, was attracted to the knowledge-translation and product-development stages. These appear to contain specific points at which knowledge is converted from one form into another in the process of solving practical problems. In our conception of translation, abstract, scientific knowledge is converted to delimited, scientific knowledge and to technological knowledge. In product-development, delimited, scientific knowledge and technological knowledge are converted to social and material technologies - to instruments directly useful to clients. Because these stages are charged with converting certain forms of knowledge into different forms within the parameters of client-needs, their task appears to be critical, complex, and especially demanding. There appears to be additional need for special attention to be given to clearer understanding of there activities.

It is felt that the operations performed in product-development are reasonably well-understood. This understanding is reflected in the detail in which its steps are presented and may be explained, in part, by the conceptual strength of systems engineering. Although important attempts (Havelock, 1974b; Rothman, 1974) recently have been made to increase the understanding

of translation, the procedures and outputs of this stage appear to need considerable refinement. For example, what types of knowledge do translators produce (we have specified two types - delimited, scientific knowledge and technological knowledge)? What specific operations (steps and sub-steps) do (or should) translators go through in converting unsynthesized, abstract knowledge to knowledge of maximum utility to developers and other users? Does the deductive approach employed in product-development apply to translation as well? Does translation represent a new role for the applied linguist/semantist, for the applied ethnoscientist? In short, there appear to be many questions about knowledge-translation to which case-studies, empirical testing and further conceptual work can contribute answers. This need may be explained, in part, by the fact that apparently few translation services currently exist. The problem, however, appears to be real, as one social worker indicates:

> Are we practitioners failing to insist loudly enough that social engineering progress be brought about by giving 'meaning' to such words as those represented in this [research] paper or will they continue to be used as mere 'shibboleths'? (Rothman, 1974:552).

As noted in the previous paragraph, product-development appears in a general sense to be fairly well understood. However, dependence on systems engineering may be more applicable to development of physical and material technologies compared with social or behavioral technologies. In other words, improvements in the ability of social-technology developers to formulate problems and draft performance appeal specifications (Steps IV-2 and 3) may require considerable development of basic and applied social science research (Stage 1).

In addition, although considerable advances in the assessment component of product analysis/assessment (Step IV-3d) have been made in recent years (Wolf, 1976) further work is needed. The social impacts of new technologies are difficult to specify and measure, and an entire methodology of assessment is needed to perform this step effectively.[25] It is possible that the assessment sub-step will emerge as a key element of product-invention and development in the future. In the cross-cultural transfer of technology, assessments of broad, socio-cultural impacts have been called for (Foster, 1969). These assessments should be integrated systematically into the actual product-development cycle as the model presented here suggests, rather than merely "tacked on" after dissemination and utilization. We suggest that further research is needed to determine how assessments can be integrated most effectively into product-development. We further suggest that this integration requires considerable development of criteria and methodology for determining appeal specifications (Step IV-3a) and environmental conditions affecting client entry-behavior.

In the knowledge-production stage, the literature is clear that much work is needed to develop and refine methodologies, conceptual tools, and communication skills of applied (particularly social) researchers. We feel that we have a reasonably good understanding of points (steps) at which improvements can be made; however, empirical studies of successful applied research projects are needed to provide information and guidance to make this activity more effective. The work of Van de Vall and others

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[25] Jones (1971) presents a "general methodology" of technology assessment: 1) define assessment task; 2) describe relevant technologies; 3) develop state-of-society assumptions; 4) identify impact areas; 5) make preliminary impact analysis; 6) identify possible action options; 7) complete impact analysis.

(1975; 1976) indicates that propositions on the conduct of applied social research and its use can be derived. A major contribution to the field may be a synthesis and elaboration of propositions concerning the practices of applied social research, similar to those by Rothman (1974) in social work.

The terms basic and applied research are used in almost all discussions of knowledge-production-and-utilization. However, there is no general agreement on the definitions or practical significance of these terms. It is generally agreed that different scientists do have different objectives, different reference groups, different channels of communication, different audiences and apparently produce differentiated products. There is the need for a clearer conceptualization of these areas and their inter-relationships as well as their relationships to the entire utilization process. It is hoped that clarification of these areas could, among others benefits, make possible more effective management by research administrators of this aspect of knowledge-production and improve knowledge-utilization by intermediate user/clients. We believe those engaged in these knowledge-production activities (by whatever names labeled) should be trained in the effective packaging of their research results. This will probably mean additional communication and "packaging" training beyond their basic discipline training. However, if the transition requirements between science and practice are to be met, effective communication is required. Our conceptualization appears to place increased responsibility on the scientist, in addition to the continuing responsibility on those in linker roles.

In summary, while adaptation and packaging of different forms of knowledge is important in each stage of knowledge-production-and-utilization, the crucial conversion of abstract knowledge to guidelines for formulating user-problems and new technologies is concentrated in the translation and development stages. The conversion process in the product development stage is relatively well-understood, when compared with conversion process in the knowledge-translation stage. We feel that each stage is capable of further development, but we feel the translation stage, and to slightly lesser degree, the development stage, (especially social technology) must receive priority in further approximations of knowledge-production-and-utilization models. It appears that perhaps for many years to come, interested scholars will have to be content with generating and testing approximations of the knowledge-production-and-utilization process. This work must be encouraged. However, we look forward to the day when scholars and practitioners can go beyond the development of approximate models to a clear, rigorous, complete model of knowledge-production-and-utilization that can be readily operationalized for practical use by all involved.

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